5X800 MW YADADRI TPS

TECHNICAL SPECIFICATION

FOR

AIR CONDITIONING SYSTEM

SPECIFICATION NO.: - PE-TS-417- 553-A002 (REV-0)

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

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			GENERAL TECHNICAL REQUIREMENT	
			FUNCTIONAL / PERFORMANCE / DEMOSTRATION / GUARANTEE TESTS	
			QUALITY ASSURANCE	
			DRAWINGS/ DOCUMENTS SUBMISSION PROCEDURE	
			PACKING PROCEDURE	
			PROJECT MANAGEMENT AND SITE SERVICES	
		C2 - C	PAINTING SPECIFICATIONS (Refer Sec-I,Sub-Section-C2C)	
	Sub Section-C4	TECHNICAL SPECIFICATION (C&I PORTION)		(Refer Sec-I,Sub-Section-C4)
Sub Section-D (Refer Sec-I)	STANDARD TECHNICAL SPECIFICATIONS			(Refer Sec-I)
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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers Supply part, Services part and Mandatory spares comprising of design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants, chemicals, reagents and consumables required for pre-commissioning, commissioning , performance testing and till one year of operation after handing over including chemicals for softening plant, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee test at site, 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 **5X800 MW YADADRI TPS..**

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 testing of **AIR CONDITIONING 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 Sec – II); 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 & requirements of different codes/standards and between respective clauses of sub-section C & sub-section D, more stringent clause 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 General Conditions of Contract (GCC).

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION

YADADRI THERMAL POWER STATION

PROJECT INFORMATION

1	Name of the Project	YADADRI Thermal Power Station
2	Station Capacity	5X800 MW (Coal based)
3	Owner	Telangana State Power Generation Corporation Limited (TSGENCO)
4	Site Location	Site is located 7 km from the NH5.
5	Latitude	*16° 42*'20.40 N
6	Longitude	79° 34'41.56 E
7	Nearest Town	30 Km Miryalaguda
8	Nearest Railway Station	6.5 Km Damercherla
9	Nearest Airport	130 Kms (Vijayawada)
10	Site Conditions	
	Ambient Temperature	
	Daily minimum (average)	10°C
	Daily maximum (average)	47°C
	Design Ambient Temperature	50°C
	Ambient temperature (performance)	38°C
	Relative Humidity for design / efficiency	48-84 %
	Annual rainfall, mm	600 mm
	Plant Elevation above MSL	85 m above MSL
	Mean Wind Speed	44 m/s
	Wind Pressure	As per the latest revision of IS 875/1987
	Seismic co-efficient	Zone-III as per IS- 1893 (Part-IV)

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : नलगोंदा
STATION : Nalgonda

अक्षांश LAT. 17°03' देशांतर LONG. 79°16' समुद्री तल माध्य से ऊंचाई HEIGHT ABOVE M.S.L. 227 मीटर METRES

पक्षणों पर आधारित BASED ON OBSERVATIONS 1975-2000

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 नम DAILY MAX	दैनिक न्यून तम DAILY MIN	माह मे 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	बाष्प 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. प. घं. Kmph
जनवरी JAN	I	989.9	21.3	19.3	30.8	18.4	33.8	16.1	36.0	17 1998	14.4	7 1992	82	21.2	2.0	1.8	13.5	0.4	155.7 1978	0.0	55.4	11 1978	
फरवरी FEB	I	988.0	23.6	21.5	33.5	20.7	36.5	18.0	39.0	26 1980	15.4	5 1988	82	24.1	3.0	2.5	7.2	0.5	14.0 1999	0.0	49.2	20 2000	
मार्च MAR	I	985.8	26.2	23.7	37.3	22.8	40.9	19.9	42.0	14 1983			80	27.4	1.7	1.4	6.5	0.4	88.5 1981	0.0	43.6	13 1981	
अप्रैल APR	I	983.6	29.2	25.5	39.6	25.5	43.0	22.4	44.5	30 1991	14.6	15 1987	73	29.7	2.1	2.0	17.6	1.0	65.6 1981	0.0	40.6	24 1981	
मई MAY	I	980.8	31.9	26.3	41.2	28.2	44.8	23.5	46.1	26 1984			63	29.7	2.7	2.5	27.0	1.4	94.3 1991	0.0	49.0	5 1981	
जून JUN	I	978.2	29.8	25.7	37.6	27.2	42.6	23.4	46.3	2 1998	21.8	12 1991	71	29.9	5.1	4.4	65.9	3.5	48.2 2000	0.0	81.7	12 1991	
जुलाई JUL	I	978.8	27.7	24.7	33.9	25.5	37.3	23.2	39.2	7 1992	22.0	2 1992	77	28.6	6.3	5.8	124.6	6.0	176.7 1977	36.8 1979	99.2	24 1977	
अगस्त AUG	I	979.6	27.1	24.3	32.8	25.0	35.4	22.8	37.5	25 1979	22.0	2 1981	78	28.2	6.1	6.0	133.0	6.7	189.0 1998	33.2 1979	88.2	14 1977	
सितम्बर SEP	I	982.0	27.4	24.4	33.6	24.9	36.4	22.8	38.5	23 1987	21.6	8 1989	77	28.3	4.9	4.2	145.5	5.8	393.1 1991	20.3 1984	152.2	21 1991	
अक्तूबर OCT	I	985.3	26.6	23.8	33.1	23.7	36.2	21.4	36.5	1 1987	19.2	28 1980	78	27.2	4.0	3.7	104.3	3.8	333.1 1981	4.2 1984	109.2	6 1987	
नवम्बर NOV	I	987.9	24.2	21.0	31.1	21.2	33.5	17.9	35.5	7 1996	14.6	27 1981	75	22.6	3.2	2.6	48.1	2.8	66.8 1991	1.1 1981	163.5	4 1987	
दिसम्बर DEC	I	990.3	21.7	18.6	30.0	18.6	32.2	15.7			12.6	16 1993	73	19.4	2.7	2.3	3.8	0.3	3.1 1987	0.0	3.1	10 1987	
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	983.9	26.7	23.4	34.8	23.7	44.3	15.9	46.3	2	12.6	16	75	26.6	3.7	3.2	696.8	32.5	631.7	631.7	163.5	4	
	II								6	1998	12	1993							1982	1982	11	1987	
वर्षोंकी संख्या NUMBER OF YEARS	I	19	19	19	19	19	21	22	19		19		19	19	18	17	20	20	16	16	23		
	II																						

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : नलगोंडा
STAION : Nalgonda

माह / MONTH	मौसम परिघटना — के साथ दिनों की संख्या — वर्षण 0.3 मि.मि.या अधिक / PPT 0.3 mm Or more	ओले / HAIL	गर्जन / THUNDER	कुहरा / FOG	धूल भरी आंधी / DUST STORM	चंड वात / SQUALL
	WEATHER PHENOMENA					
	No. OF DAYS WITH					
जनवरी JAN	0.5	0.0	0.0	0.0	0.0	0.0
फरवरी FEB	0.6	0.0	0.0	0.0	0.0	0.0
मार्च MAR	0.7	0.0	0.1	0.0	0.0	0.0
अप्रैल APR	1.1	0.0	0.0	0.0	0.0	0.0
मई MAY	1.8	0.0	0.0	0.0	0.0	0.0
जून JUN	4.5	0.0	0.0	0.0	0.0	0.0
जुलाई JUL	7.1	0.0	0.1	0.0	0.0	0.0
अगस्त AUG	7.7	0.0	0.0	0.0	0.0	0.0
सितम्बर SEP	6.6	0.0	0.0	0.0	0.0	0.0
अक्तूबर OCT	3.9	0.0	0.0	0.0	0.0	0.0
नवम्बर NOV	3.3	0.0	0.0	0.0	0.0	0.0
दिसम्बर DEC	0.4	0.0	0.0	0.0	0.0	0.0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	39.3	0.0	0.1	0.0	0.0	0.0
वर्षोंकी सं NUMBER OF YEARS	22					

माह / MONTH	पवन — पवन की गती के साथ दिनों की संख्या (कि. मी. प्र. घं.) — 62 या अधिक / 62 Or more	20-61	1-19	0
	WIND			
	No. OF DAYS WITH WIND SPEED (Km. p. h.)			
जनवरी JAN	0	0	29	2
	0	0	31	0
फरवरी FEB	0	0	28	0
	0	0	28	0
मार्च MAR	0	1	30	0
	0	1	30	0
अप्रैल APR	0	0	29	1
	0	0	30	0
मई MAY	0	0	31	0
	0	0	31	0
जून JUN	0	1	29	0
	0	1	29	0
जुलाई JUL	0	1	30	0
	0	0	31	0
अगस्त AUG	0	1	30	0
	0	0	31	0
सितम्बर SEP	0	0	29	1
	0	0	29	1
अक्तूबर OCT	0	0	29	2
	0	0	30	1
नवम्बर NOV	0	0	26	4
	0	0	28	2
दिसम्बर DEC	0	0	29	2
	0	0	30	1
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	1	5	346	13
	1	3	355	6
वर्षोंकी सं NUMBER OF YEARS	22			

माह / MONTH	पवन — पवन की दिशा के दिनों की संख्या का प्रतिशत — N	NE	E	SE	S	SW	W	NW	CALM
	WIND								
	PERCENTAGE No. OF DAYS WIND FROM								
जनवरी JAN	0	30	3	39	3	4	0	11	10
	0	29	10	51	3	1	0	4	2
फरवरी FEB	1	26	1	55	3	5	0	7	2
	1	19	7	64	3	2	0	2	2
मार्च MAR	1	25	1	55	3	5	0	9	1
	2	12	5	69	1	4	0	5	2
अप्रैल APR	0	20	1	46	4	18	0	8	3
	1	11	2	65	3	8	0	8	2
मई MAY	1	14	0	27	3	21	3	30	1
	1	20	2	29	2	19	2	24	1
जून JUN	1	2	0	6	0	36	8	47	0
	2	5	0	7	0	43	6	35	2
जुलाई JUL	1	1	0	1	0	43	10	44	0
	0	3	0	3	0	40	9	43	2
अगस्त AUG	1	1	0	2	0	32	8	55	1
	2	4	0	2	0	26	8	57	1
सितम्बर SEP	1	6	0	11	1	29	4	42	6
	4	17	1	10	0	25	6	31	6
अक्तूबर OCT	1	29	4	16	1	15	2	23	9
	2	37	6	26	1	7	2	12	7
नवम्बर NOV	3	33	7	18	2	4	0	19	14
	2	38	11	24	2	6	1	8	8
दिसम्बर DEC	3	46	3	22	1	2	1	14	8
	1	55	7	28	1	1	0	3	4
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	1	19	2	24	2	18	3	26	5
	1	21	4	33	1	15	3	19	3
वर्षोंकी सं NUMBER OF YEARS	22								

माह / MONTH	मेघ — मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश — 0	से-2	3-5	6-7	8
	CLOUD				
	No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS				
जनवरी JAN	25	0	2	1	3
	25	2	3	0	1
फरवरी FEB	18	1	3	2	4
	22	1	4	1	0
मार्च MAR	23	2	3	1	2
	26	1	2	1	1
अप्रैल APR	20	2	4	2	2
	21	1	5	2	1
मई MAY	19	2	5	2	3
	6	2	18	3	2
जून JUN	5	1	5	4	15
	2	1	4	4	19
जुलाई JUL	2	1	3	5	20
	1	0	3	4	23
अगस्त AUG	2	1	5	3	20
	0	0	1	2	28
सितम्बर SEP	4	1	6	4	15
	1	0	2	3	24
अक्तूबर OCT	18	1	5	2	5
	22	1	3	2	3
नवम्बर NOV	16	1	4	3	6
	20	1	3	2	4
दिसम्बर DEC	21	1	4	1	4
	23	2	3	1	2
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	205	13	48	29	70
	238	14	39	26	48
वर्षोंकी सं NUMBER OF YEARS	21				

माह / MONTH	मेघ — निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश — 0	से-2	3-5	6-7	8	कुहरा 8
	CLOUD					
	No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS					
जनवरी JAN	25	0	2	1	3	0
	27	1	2	0	1	0
फरवरी FEB	21	1	2	1	3	0
	24	1	3	0	0	0
मार्च MAR	25	1	3	1	1	0
	27	1	2	1	0	0
अप्रैल APR	21	1	4	2	2	0
	22	1	4	2	1	0
मई MAY	21	2	4	1	3	0
	20	2	5	2	2	0
जून JUN	7	1	4	3	15	0
	3	1	5	4	17	0
जुलाई JUL	4	1	2	3	21	0
	1	1	3	4	22	0
अगस्त AUG	3	1	4	2	21	0
	1	0	1	2	27	0
सितम्बर SEP	5	1	4	3	17	0
	2	0	2	2	24	0
अक्तूबर OCT	21	0	3	2	5	0
	23	1	3	1	3	0
नवम्बर NOV	21	1	2	2	4	0
	22	1	2	2	3	0
दिसम्बर DEC	23	1	3	1	3	0
	24	2	2	1	2	0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	238	11	37	22	57	0
	257	14	34	20	40	0
वर्षोंकी सं NUMBER OF YEARS	21					

माह / MONTH	दृश्यता — दृश्यता सहित दिनों की संख्या — 1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक
	VISIBILITY				
	No. OF DAYS WITH VISIBILITY				
जनवरी JAN	0.6	6.7	21.3	2.3	0.1
	0.0	1.8	3.1	24.1	1.9
फरवरी FEB	0.1	7.8	18.0	1.7	0.5
	0.0	0.4	4.2	21.2	2.2
मार्च MAR	0.0	3.8	24.1	2.9	0.3
	0.0	0.3	4.4	24.2	2.1
अप्रैल APR	0.0	3.0	21.5	4.3	1.1
	0.0	0.4	3.8	24.3	1.5
मई MAY	0.0	3.1	22.5	3.4	1.9
	0.0	0.6	3.6	24.4	2.4
जून JUN	0.0	4.7	20.2	3.1	2.0
	0.0	1.1	5.2	21.4	2.3
जुलाई JUL	0.0	4.3	23.1	1.9	1.6
	0.0	1.7	4.7	22.4	2.2
अगस्त AUG	0.0	4.1	22.8	2.5	1.6
	0.0	2.8	3.9	22.7	1.6
सितम्बर SEP	0.0	3.2	20.9	3.6	2.3
	0.0	1.3	4.5	22.2	2.1
अक्तूबर OCT	0.1	3.7	22.4	3.8	1.1
	0.1	1.5	3.9	23.6	2.0
नवम्बर NOV	0.0	8.8	17.8	2.9	0.4
	0.1	3.7	5.3	17.6	3.4
दिसम्बर DEC	0.1	6.8	20.8	3.3	0.0
	0.0	4.6	3.3	21.9	1.1
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	0.8	60.1	255.4	35.6	13.0
	0.1	20.1	49.9	269.9	25.0
वर्षोंकी सं NUMBER OF YEARS	22				

SECTION: I

SUB-SECTION: C

TECHNCAL SPECIFICATIONS

SECTION-I

SUB-SECTION-C1

SPECIFIC TECHNICAL REQUIREMENT – COMPLETE PLANT EXCEPT SWITCHYARD AREA

1. **FUNCTION**

This specification includes, but not limited to Supply part, Services part and Mandatory spares comprising of design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants, chemicals, reagents and consumables required for pre-commissioning, commissioning , performance testing and till one year of operation after handing over including chemicals for softening plant, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee test at site, training of customer/client O&M staff and handover in flawless condition of the package to the end customer in line with drawings/ documents/ test procedures approved by BHEL/Customer for Air conditioning System except for following buildings:

a) Canteen building
b) Permanent stores and store office
c) Security building
d) Chemical Lab building (PCRI)
e) Simulator building
f) Main gate building
g) Workshop building
h) Fire station building

Bidder to note that even though the supply of Air conditioning equipment's of the above 8 buildings are not included in their scope, the engineering and selection/sizing of equipment's of Air conditioning system of these 8 buildings shall still be included in their scope.

For Air conditioning requirement of Switchyard, kindly refer **Section II**

2. **SYSTEM DESCRIPTION**

2.1 POWER HOUSE BUILDING

Water-cooled Chilled water type air conditioning plant shall be provided to cater to the air conditioning requirements of the following areas of **unit #1, #2, #3, #4, #5**:

- Unit Control Room.
- Control Equipment Room (CER)
- Computer Room
- Conference Room
- UPS Room
- Battery charger Room (Cassette AC shall be provided)
- SWAS Room
- Shift in-charge room

- Office area etc.

.

AC PLANT-1 (shall cater to the air conditioning areas of Unit#1 & 2):

The AC Plant shall consist of 2 x 100% water-cooled Screw chiller and shall cater to the requirements of Unit #1 & 2. The condenser cooling water shall be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S). FRP induced draft cooling towers. The chilled water produced by the chilling units shall be circulated to the Air Handling Units by (1W + 1S) centrifugal pump sets. These AHU shall be located in AHU rooms located adjacent to air-conditioned areas in Power House Building. The conditioned air from AHUs is distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames. The return air is led back to the AHU Room in ducts for air conditioned areas at 17.0M level in control tower. There shall be a separate AHU rooms for the air conditioning of UPS room and control room areas at 17.0M level in control tower. The AHU room for the UPS room shall be located at 32.5 M whereas the AHU room for the control room areas shall be located at 24M.

The 2 x 50 % AHU's at 24.0M serving the control room areas at 17.0M shall be provided with 3 X 50% DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor. M.S. Scroll casing of the fan will be suitably painted.

The 2 x 50 % AHU's at 32.5M serving the UPS room at 17.0M shall be provided with 2 X 100% DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor. M.S. Scroll casing of the fan will be suitably painted.

FCU shall be provided for SWAS room for Unit-1 & 2.

Individual capacities of Air Handling Units/Fan Coil Units should be calculated and furnished by the Bidder.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be taken to a sump through HDPE piping at ground level near each building gravity/pumping for further handling in ETP system (by other).

One no. Non Chemical water treatment device at the common outlet of CW pumps shall be provided.

One no. expansion tank of MS spray galvanised or FRP and shall be of adequate thickness & suitably reinforced and insulated shall be provided.

Two nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

AC PLANT-2 (shall cater to the air conditioning areas of Unit#3 & 4):

The AC Plant shall consist of 2 x 100% water-cooled Screw chiller and shall cater to the requirements of Unit #1 & 2. The condenser cooling water shall be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S) FRP induced draft cooling towers. The chilled water produced by the chilling units shall be circulated to the Air Handling Units by (1W + 1S) centrifugal pump sets. These AHU shall be located in AHU rooms located adjacent to air-conditioned areas in Power House Building. The conditioned air from AHUs is distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames. The return air is led back to the AHU Room in ducts for air conditioned areas at 17.0M level in control tower. There shall be a separate AHU rooms for the air conditioning of UPS room and control room areas at 17.0M level in control tower. The AHU room for the UPS room shall be located at 32.5 M whereas the AHU room for the control room areas shall be located at 24M.

The 2 x 50 % AHU's at 24.0M serving the control room areas at 17.0M shall be provided with 3 X 50% DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor. M.S. Scroll casing of the fan will be suitably painted.

The 2 x 50 % AHU's at 32.5M serving the UPS room at 17.0M shall be provided with 2 X 100% DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor. M.S. Scroll casing of the fan will be suitably painted

FCU shall be provided for SWAS room for Unit-3 & 4.

Individual capacities of Air Handling Units/Fan Coil Units should be calculated and furnished by the Bidder.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be taken to a sump through HDPE piping at ground level near power house building by gravity/pumping for further handling in ETP system (by other)

One no. Non Chemical water treatment device at the common outlet of Condenser Water pumps shall be provided.

One no. expansion tank of MS spray galvanised or FRP and shall be of adequate thickness & suitably reinforced and insulated shall be provided.

Two nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

AC PLANT-3 (shall cater to the air conditioning areas of Unit#5):

The AC Plant shall consist of 2 x 100% water-cooled Screw chiller and shall cater to the requirements of Unit #1 & 2. The condenser cooling water shall be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S) FRP induced draft cooling towers. The chilled water produced by the chilling units shall be circulated to the Air Handling Units by (1W + 1S) centrifugal pump sets. These AHU shall be located in AHU rooms located adjacent to air-conditioned areas in Power House Building. The conditioned air from AHUs is distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames. The return air is led back to the AHU Room in ducts for air conditioned areas. There shall be AHU room located at 24 M for the air conditioning of UPS room and control room areas at 17.0M level in control tower.

The 2 x 50 % AHU's at 24.0M serving the control room areas at 17.0M shall be provided with 3 X 50% DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor. M.S. Scroll casing of the fan will be suitably painted.

FCU shall be provided for SWAS room for Unit-5.

Individual capacities of Air Handling Units/Fan Coil Units should be calculated and furnished by the Bidder.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be taken to a sump through HDPE piping at ground level near power house building by gravity/pumping for further handling in ETP system (by other)

One no. Non Chemical water treatment device at the common outlet of Condenser water pumps shall be provided.

One no. expansion tank of MS spray galvanised or FRP and shall be of adequate thickness & suitably reinforced and insulated shall be provided.

Two nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

SERVICE BUILDING

Water-cooled Chilled water type air conditioning plant shall be provided to cater to the air conditioning requirements Service Building.

AC PLANT-4 & 5 (shall cater to the air conditioning areas of Service Building #1 & 2 respectively):

Each AC Plant shall consist of 2 x 100% water-cooled Screw chiller and shall cater to the requirements of each floor of the service building. The condenser cooling water shall

be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S) FRP induced draft cooling towers. The chilled water produced by the chilling units shall be circulated to the Air Handling Units by (1W + 1S) centrifugal pump sets. These AHU shall be located in AHU rooms on each floor of the service building adjacent to air-conditioned areas (Each AHU room shall contain 2 x 50% capacity AHU).

Individual capacities of Air Handling Units should be calculated and furnished by the Bidder. Further the no. and capacity of the DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor for each AHU shall be calculated and furnished by the bidder during detail engineering.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be taken to a sump through HDPE piping at ground level near power house building by gravity/pumping for further handling in ETP system (by other)

One no. Non Chemical water treatment device at the common outlet of Condenser water pumps shall be provided.

One no. expansion tank of MS spray galvanised or FRP and shall be of adequate thickness & suitably reinforced and insulated shall be provided.

Two nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

2.2 ESP BUILDING

Water cooled precision type package AC shall be provided for ESP control room for each unit i.e. **unit #1, #2, #3, #4, #5.**

AC PLANT-6, 7, 8, 9, & 10 (shall cater to the air conditioning areas of ESP Control Building of #1, 2, 3, 4 & 5 respectively):

Each AC Plant shall consist of 3 Nos (2W + 1S) Water cooled precision type Package AC to cater to the air conditioning requirements ESP Control Building. The condenser cooling water shall be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S) FRP induced draft cooling towers.

One no. Non Chemical water treatment device at the common outlet of Condenser water pumps shall be provided.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be taken to a sump through HDPE piping located in boiler area by gravity/pumping for further handling in ETP system (by other)

One nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

2.3 FGD MCC & CONTROL ROOM

Water cooled precision type package AC shall be provided for FGD control room for each Stage i.e. Stage **#1 & #2.**

AC PLANT-11 & 12 (shall cater to the air conditioning areas of FGD Control Room of Stage # 1 & 2 respectively):

Each AC Plant shall consist of 5 Nos (3W + 2S) Water cooled precision type Package AC to cater to the air conditioning requirements FGD Control Building. The condenser cooling water shall be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S) FRP induced draft cooling towers.

One no. Non Chemical water treatment device at the common outlet of Condenser water pumps shall be provided.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and **cooling tower blow down** shall be taken to a sump **through HDPE piping located** near respective FGD Control room building by gravity/pumping for further handling in ETP system (by other)

One nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

2.4 DM PLANT CONTROL ROOM AND ITS ASSOCIATED AREAS

Water cooled precision type package AC shall be provided for DM Plant control room & adjoining areas**.**

AC PLANT-13 (shall cater to the air conditioning areas of DM Plant Control Room):

Each AC Plant shall consist of 3 Nos (2W + 2S) Water cooled precision type Package AC to cater to the air conditioning requirements FGD Control Building. The condenser cooling water shall be circulated by means of (1W + 1S) centrifugal pump sets and (1 W + 1S) FRP induced draft cooling towers.

One no. Non Chemical water treatment device at the common outlet of Condenser water pumps shall be provided.

(1W +1S) water softening plant to take care of the make-up water requirements of the cooling tower. The reject of water softening plant and cooling tower blow down shall be

taken to a neutralising pit of DM plant sump through HDPE piping by gravity/pumping for further handling in ETP system (by other)

One nos. Make-up water tank made of M.S RL or FRP and of adequate thickness & suitably reinforced. This tank will supply make-up water to Cooling towers and make up to Expansion tank and humidifiers shall be taken from the make-up inlet to softening plant directly.

2.5 ADMINISTRATION BUILDING

Air cooled type package AC shall be provided for each floor of administration building. **6 nos. PAC shall be provided in each floor (3 nos. on each wing),** capacity shall be decided based on heat load and equipment rating available. Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.

2.6 SPLIT TYPE AIR CONDITIONERS/CASSETTE TYPE AC/AIR COOLED PACKAGE AC

Split type/Cassette ACs/Air cooled Package ACs (air cooled) shall be provided to cater to the air conditioning requirements of control room areas having workstation for auxiliary plant.

Split type/Cassette ACs/Air cooled Package ACs shall be suitable for operating at 50 Deg. C ambient.

For selection of numbers of split AC's/Cassette AC's , refer to clause 2.05.00 of section C2-A, customer specifications.

Hand operated remote and other accessories as specified. Local Distribution Boards containing isolating Switch / MCB shall be provided for Split Air Conditioners/Cassette Air conditioners and FCUs. Each split unit/ Cassette Air conditioners shall also be provided with suitable rating stabiliser.

3. DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

3.1.1 Outdoor conditions shall be considered as follows: -

	Summer	**Monsoon**	**Winter**
DBT (°C)	42.7	30.9	15.7
WBT (°C)	26.5	26.3	13.6

3.1.2 The inside design conditions to be maintained are as follows: -

22°C ± 1^0C & RH 55% ± 5% for control room, CER, Computer room, UPS rooms, AVR room etc.

24°C ± 1^0C & RH not exceeding 60% for non-critical areas like offices, conference room, SWAS room, etc. and the areas served by split AC.

3.1.3 Fresh air at the rate of 1.5 air changes per hour for the control rooms and 1 air change per hour for office areas or at least 34 Cu. M/Hr. per person, whichever is higher. For other areas, Fresh air shall be considered as per ISHRAE (latest Version).

3.1.4 A design margin of 10% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area. An overall margin of 10% on calculated cooling load shall be considered in selecting Plant capacity.

3.1.5 Lighting load considered shall be 21.4 W/m2 except shift in charge engineer's room and offices where 16 W/m2 shall be considered.

3.1.6 The Occupancy considered shall be 1 person in 12SQM or (actual).

3.1.7 Necessary Heater and Humidifier shall be provided.

3.1.8 Efficiency of centrifugal fan and pump shall not be less than 70%.

3.1.9 For other design parameters refer to clause 5.01.00 and other relevant clauses of section C2-A, customer specifications.

3.1.10 **SPECIAL CONSIDERATION**

- Water flow rate for chilled water pump selection: 0.7 CMH/TR.
- Water flow rate for condenser water pump selection: 1.0 CMH/TR.
- Condenser water pumps, chilled water pumps, AHUs and FCUs shall have further 10% margin on their flow capacities.
- Water flow rate for Cooling Tower Selection shall be equivalent to finally selected condenser water pump capacity.
- Chiller/Water Cooled Precision AC's/Water cooled Package AC's shall be designed for minimum condensate inlet water temperature as 33 Deg C
- Design margins in various equipment shall be as per relevant clauses of section C2-A, customer specifications.
- All equipment shall be of high quality and high efficiency meeting the stipulated power consumption as defined elsewhere in the specifications.

3.2 SYSTEM CAPACITY AND CONFIGURATION:

For system capacities and configuration please refer Annexure-D.

3.3 LAYOUT CONSIDERATION:

For location of the AC Plants-1 to 13 please refer Annexure-C.

4.0 BRIEF SPECIFICATION OF AC EQUIPMENT

4.1 Water Cooled Chiller Package

a) Refer to clause 3.01.00, 4.01.00 & 6.03.00 and other relevant clauses of section C2-A, customer specifications.

b) The IKW/TR of screw chillers shall not be more than 0.7 at 100%.

c) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc shall be provided with each screw chiller as per PID indicated in Annexure-A.

4.2 Water Cooled Precision Package AC

a) For water cooled precision type package, refer to clause 4.02.00, 4.03.00, & 6.12.01 and other relevant clauses of section C2-A, customer specifications

4.3 Chilled & Condenser Water Pump sets

a) Refer to clause 3.01.05,3.01.06, 6.04.00 and other relevant clauses of section C2-A, customer specifications.

b) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc shall be provided with pump as per PID indicated in Annexure-A.

c) Vibration pads/shims shall be provided for isolation vibrations

4.4 Cooling Tower

- Design ambient wet bulb temp: 29 deg C.
- Approach: 4 deg C.
- COC-5

Induced draft (single cell) FRP type shall consist of all accessories i.e. fan, motor, FRP basin, FRP louvre, PVC eliminators, nozzles, make up connection, drains overflow & piping, valves & fittings, strainer of brass wire mesh, ladder and supporting structure and all accessories as specified shall be provided.

Refer to clause 3.01.07, & 6.05.00 and other relevant clauses of section C2-A, customer specifications

4.5 Air Handling Units (Double Skin Type)

Refer to clause 3.02.00, 6.08.01 and 6.08.02, 6.17.01 and other relevant clauses of section C2-A, customer specifications.

a) High efficiency filter having an efficiency of 99% down to 5 microns mounted in supply air duct shall be provided for air conditioning of all areas excepting areas served by FCUs.

b) Dry panel type pre-filters (50mm thick) having efficiency of 90% down to 10microns shall be provided for all other AC areas.

c) Motors shall be installed inside the AHU.

d) Accessories (valves, pressure gauges, water flow switches, controls and instruments etc shall be provided with pump as PID indicated in Annexure-A.

e) Drain piping from the AHUs up to nearest drain point.

f) Serrated rubber pads for vibration isolation

4.6 Strip Heater Package & Humidification Package

a) One set of electrical strip heater package of suitable capacity shall be provided in supply air duct. Heater package shall be connected with thermostat / Humidistat which will be provided in return air path inside AHU Room / Package AC Room. Each Strip heater supplied shall have 3 Banks. No of banks operating at a moment shall be decided based on inside temperature and humidity level.

Temp gauge, temp element shall also be provided and the same shall be hooked with PLC system. RH and temp sensor shall be provided and the same shall be hooked with PLC system.

b) One No. electrode humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc for each AHU Room.

c) Refer to relevant clause 3.05.00, 3.06.00, 6.12.01, 6.14.01, 6.14.02 and other relevant clauses of section C2-A, customer specifications

4.7 Sheet Metal Work

a) Refer to clause 6.10.00 and other relevant clauses of section C2-A, customer specifications.

b) Supply air diffusers / grilles (Frame and Louvers of Diffuser/Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no Volume control Damper.

c) For fire damper refer to clause 3.08.00, 6.10.00, 4.01.00, 6.10.11(ii) and other relevant clauses of section C2-A, customer specifications.

d) Motorized fire damper will be installed at supply and return air duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply and return air duct will be closed on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi- sensor detectors in the return air duct for all air conditioned areas. Also respective Air Handling Units, Air washers/UAFs shall trip on receiving fire signal from fire protection system

4.8 Smoke Exhaust fan

a) Refer to clause 2.08.06, 3.07.00 and other relevant clauses of section C2-A, customer specifications.

4.9 Insulation

a) Refer to clause 6.11.00 and other relevant clauses of section C2-A, customer specifications

4.10 Split Air Conditioner

For the split type air conditioner/Cassette air conditioner, the condensing unit is to be located on roof or at grade and indoor units to be located inside the air-conditioned areas. Each unit shall be complete with reciprocating / rotary compressor, air cooled condenser, cooling coil, evaporator fan, dry panel filters, necessary refrigerant piping (insulated suction lines), necessary controls and first charge of refrigerant and oil etc. and damper at outlet of the fan.

Hand operated remote and other accessories as specified.

Split Air Conditioner/Cassette air conditioner shall be of maximum rating available as per BEEE rating regulation presently prevalent and latest model.

For further details refer to relevant clauses of Section-C, Sub-Section C2A.

4.11 Water Softening Plant

Each Softening plant of various AC systems (as defined in tender specification) shall be designed for **effective capacity of cooling tower makeup water requirement considering the evaporation, cooling tower blow down, misc. drift losses and water required for regeneration plant**. The service cycle (i.e., time between two successive regeneration) shall not be less than 20 Hrs.

The clarified water analysis is attached in Sub-Section-E, Annexure-X of this specification. The make-up water to AC Cooling Tower will be a soft water (Total Hardness ~ 20-30 ppm as CaCo3) which shall be achieved through the blending of clarified & soft water (Softening plant Outlet) the CT is expected to operate at **5 Cycle of concentration** & accordingly provision for suitable blowdown to be provided.

The softening plant shall be resin based & it is proposed to have it on a prefabricated & preassembled skid (comprising of Softener, ACF & DMF) to minimize Site activities.

Suitable disposal of brine solution shall be envisaged as shown in sketch attached (Refer Annexure A).

The softening plant shall be complete with all instrumentation & required facilities as per the system requirement including initial fill of resin.

Suitable cooling water treatment program (Viz scale inhibitor/Corrosion inhibitor/Bio dispersant etc.) must be dosed to maintain a corrosion and scale free water chemistry in the cooling water circuit. The required chemicals for initial commissioning and further till handing over shall be in the scope of bidder. Further the reject of the water softening plant shall be terminated at the nearest ETP pit by the bidder.

As soft water shall be corrosive in nature, piping and valves from softening plant to make up water tank and from make water tank up to cooling tower shall be of MS RL or suitable material which shall be decided during detail engineering without any implication.

Industrial Salt for Water Softening plants of air conditioning systems to be supplied on as and where basis as per site requirement by the bidder. Minimum Quantity of Salt for Water Softening Plant is specified in the Price Schedule. Additional Quantity, if any shall be supplied on pro-rata basis by the bidder.

4.12 Online Non Chemical Water Treatment Equipment

a) Refer to clause 6.14.03 and other relevant clauses of section C2-A, customer specifications.

4.13 Piping, Valves Etc

a) Refer to clause 6.06.00, 6.07.00 and other relevant clauses of section C2-A, customer specifications.

b) Condenser cooling water and Chilled water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I, for higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade.

c) Drain water piping shall be of M.S. heavy grade. Condensate drain piping shall be insulated as per the specification (Refer Section C2-A, customer specifications).

d) HDPE Piping (1"/2"/3") complying to IS 4984, PN 10, PE80 carbon black, UV rating) along with valves shall be used for transferring softening plant reject and cooling tower blow down to nearest ETP sump.

4.14 Electrical Items

Refer to clause 6.16.00 and other relevant clauses of section C2-A, customer specifications and section C-3, electrical portion of specifications.

4.15 ETP Pumps (For handling of Softening Plant Rejects)

Polypropylene (PP) Monoblock / split pumps shall be used for the carrying the rejects of the water softening plant to the nearest ETP pits in case gravity flow to ETP sumps is not feasible due to layout constraints. The pump shall be complete with casing, impeller, renewable type wearing rings, shaft, shaft sleeve, bearings, stuffing box, Mechanical Seal (if applicable), cowlings, base plate etc. as applicable.

Material of the pump shall preferably as follow (all material shall be of tested quality).

a) Casing & Impeller – Polypropylene

b) Stuffing Box & Shaft – SS316

c) Mechanical Seal – Rubber Bellow Seal

d) Face – Carbon / Ceramic.

4.16 Fresh Air Fans

Fresh air unit for Control room areas and areas served by Precision air conditioners shall consist of a tube axial flow/centrifugal fan with drive motor, inlet louver with bird screen, dry panel HDPE filters, volume control damper, supports, supporting structures etc. 1 x100% capacity Fresh air unit shall be provided in each AHU room / PAC room.

4.17 For other items refer to the relevant clauses of section C2-A, customer specifications.

5 CONTROL AND INSTRUMENTATION -

1. Stage wise PLC (Stage # 1 & 2) has been envisaged for Air conditioning and ventilation system. Stage # 1 comprises of Unit # 1 & 2 and Stage # 2 comprises of Unit # 3, 4 & 5 respectively.

   a. Following areas wherein Air conditioning and ventilation system has been envisaged to be controlled and monitored from Stage # 1 PLC located in AC plant control room at ground floor of CCR/CER Stage # 1 (Unit # 1 & 2)

      i. Power house (Unit # 1 & 2)
      ii. ESP buildings (Unit # 1 & 2)
      iii. FGD Control room (Stage # 1)
      iv. Service Building (Stage # 1)
      v. Softening plants provided for AC plants located in above areas

   b. Following areas wherein Air conditioning and ventilation system has been envisaged to be controlled and monitored from Stage # 2 PLC located in AC plant control room at ground floor of CCR/CER Stage # 2 (Unit # 3 & 4)

      i. Power house (Unit # 3, 4 & 5)
      ii. ESP buildings (Unit # 3,4 & 5)
      iii. FGD Control room (Stage # 2)

iv. Service Building (Stage # 2)

v. Softening plants provided for AC plants located in above areas

2. Switchyard and DM plant along with softening plants shall be hooked to PLC of both stages.
3. Microprocessor based Control Panel with GIU for Control and Operation of Air Conditioning System for Admin Building shall be provided as specified in technical specification elsewhere
4. Chiller, Water Cooled Precision ACs, Water Cooled Package ACs, Air cooled Precision ACs and Air cooled Package ACs shall be provided with microprocessor controller also as specified in technical specification elsewhere
5. AWU and UAF units of ventilation package for power house buildings (stage # 1 & stage 2), ESP control and FGD control buildings (stage # 1 & stage 2) shall be also be controlled through PLC's provided in respective stages.
6. For details of PLCs, RIO panels and associated equipment, kindly refer C & I specification (Sub Section-C4)

6 ACCEPTANCE TEST

Room condition test shall consist of taking the reading of dry bulb and wet bulb temp at different locations points to be mutually decided at site in the areas which are air-conditioned by the respective system/plant. Room condition test shall be done after stabilization of the system.

The dry and wet bulb temp shall be measured by measured by sling psychrometer which will have accuracy of +/-0.5% with least count of 0.5 degC. This will be carried out for 72 hrs continuously and readings will be taken every six hours. Standby equipment should be changed over during these 72 hours.

This test shall be carried out during month April to June when the dry bulb temp is generally high and during. Relative humidity shall be determined from psychometric chart

All shop testing and test at site as specified shall be carried out.

Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

Besides the system performance as above, bidder shall guarantee major technical parameters of various equipment's as per design basis / details furnished.

7 GENERAL NOTES

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.

2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.

3) All drawings and documents shall be computer based.

4) All commissioning spares, consumables, lubricants, chemicals, reagents required till handing over and till one year of operation after handing over of the system, shall be provided

5) 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. Standard QP format is enclosed in the technical specification for reference.

6) Indicative list of makes is enclosed as per Sub-Section-E, Annexure-I. However, these makes shall be subject to Customer & BHEL approval during detail engineering Stage.

7) Fixing frame works for diffusers and grilles in the scope of Vendor.

8) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

9) 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) Drain piping for AC equipment shall be terminated to the nearest drain by bidder

11) Vendor shall furnish schedule of power and control cables. Vendor shall also furnish cable termination details interconnection drawings etc. during detail engineering stage.

12) The tools and machine required for erection of equipment shall be arranged by Vendor.

13) Minimum Tools & tackles has been specified. Any additional tools & tackles as required for regular maintenance shall be supplied by Vendor.

14) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

15) Instrument for testing shall be calibrated by Air-conditioning plant supplier before taking up testing.

16) Temperature gauges shall be provided with thermo wells and fixing arrangement.

17) Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.

18) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.

19) Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

20) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipment as per design basis / details furnished.

21) The guarantee tests shall be performed as per clause no. 4.11.00 of General technical requirement (Sub Section – C2B) and Clause no.11.00.00 of technical requirement (Sub Section C2A) of customer specification.

22) For motorized fire damper / 3 Way valve actuators / motorised valves, power supply shall be derived by vendor from respective control panels. BHEL shall not provide any feeder for them. 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.

23) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements for installing the equipment as per the specification and layout requirements given in the specifications.

24) 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.

25) In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

26) Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

27) 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 as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

28) Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

29) Flat, platform type RCC / PCC foundation shall be provided for installing AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners, as applicable, to secure the equipment obtain parameters related to vibration and noise.

30) Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.

31) RCC foundation of cooling tower, tanks, pumps, water softening plants, AHU's, Precision AC's , Package AC's shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by air-conditioning plant supplier.

32) Air-conditioning plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

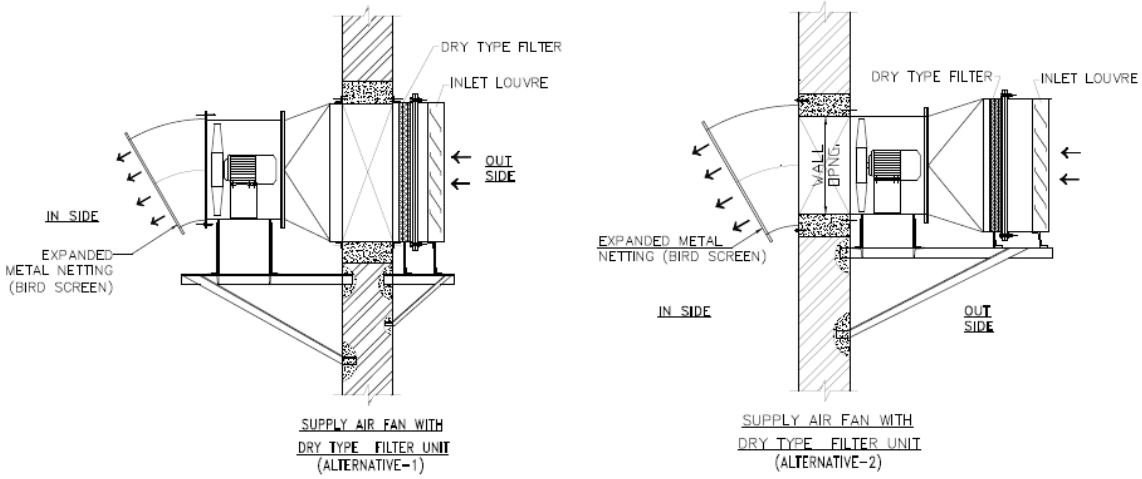
33) Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.

34) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.

35) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification during detail engineering.

36) Training of officials, for AC system shall be provided as per customer specification Section I C2-B.

37) Supports required for supporting the fan and/or filter section for FA fans shall be under bidder's scope



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38) The sizes of equipment's mentioned in this specification are minimum requirement. Bidder to submit the basis of design, all calculations including heat load calculations for all seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc during detail engineering and the same are subject to Customer approval during detail engineering stage without any commercial implication.

39) All drawings and documents shall be computer based.

40) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by bidder.

41) Construction of AC plant room, air handling unit room, foundations for AC equipment's for the powerhouse (all units), Service building #1 & 2, ESP Control room, FGD MCC and Control Room, DM Plant Control Room, Admin building and other building wherein Package AC's are provided, based on the inputs furnished by the vendor, shall be in BHEL/Customer scope. However, making good, the civil works after completion of erection of HVAC equipment's for the above mentioned area and any other area in BHEL scope, where bidder's equipment's are going to be installed is in bidder' scope. Sealing of duct opening, pipe Opening, Fan Opening, anchoring and fastening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

8 EXCLUSIONS

Items of works listed below are excluded from scope of the air-conditioning plant supplier.

a) Construction of AC plant room, air handling unit room, foundations for AC equipments.

b) False ceiling, drop ceiling.

c) Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers. However minor civil work like making opening to suit / finishing of

opening, sealing of duct opening, grouting of foundation bolts including special type of grouting like GPX2 etc. are in the scope of AC system vendor.

d) Provision of drain traps / points,

e) For Electrical scope, refer Electrical scope matrix sheet.

9 TERIMINAL POINTS

1 Instrument and Service air: Refer Instrument and service air distribution scheme

2 Service water: Refer Annexure – B & Service water scheme in Section –III, Sub-Section-7.

10 ANNEXURES

Annexure-A: P&I Diagram for AC Plant and Scheme for Water Softening Plant (6 Sheets)

Annexure-B: Make-Up Water Scheme

Annexure-C: Locations of AC Plant rooms and Areas for Air conditioning in the service building, Power House, ESP Building, FGD Control Room.

Annexure-D : System Capacity and Configuration

Annexure-E : Heat Dissipation for Power House

LOW PRESSURE PIPING, VALVES AND SPECIALTIES

1.00.00 **GENERAL INFORMATION**

This section covers all the low-pressure piping up to 400mm NB size, associated valves and specialties that include but is not limited to the following systems.

1.01.00 Service Air System - shall consist of distributions service air to different buildings.

1.02.00 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers.

1.03.00 Demineralised Water Supply system including hot well make-up water piping from condensate storage tank.

1.04.00 Demineralised Water closed cycle cooling system.

1.05.00 Service water system.

1.06.00 Potable water system.

1.07.00 Any other low pressure piping as found necessary during detail engineering shall also be included.

2.00.00 **CODES AND STANDARDS**

2.01.00 In addition to the requirements spelt out in Volume IIA, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:

2.01.01	IS-1239 [Part-I & II]	:	Mild steel tubes, tubular and other wrought steel fittings.
2.01.02	IS-3589	:	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
2.01.03	IS-554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
2.01.04	IS-1363 [Part-I & II]	:	Hexagonal head bolts, screws and nuts (size range M5 M36)

2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150)
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers
2.01.10	IS-2712	:	Compressed asbestos fibre jointing
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged
2.01.13	ANSI B-16.11 ANSI B-36.10	: :	Forged steel fittings, Socket-welding and Threaded. Steel pipes thickness
2.01.14	API-600	:	Steel gate valves
2.01.15	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.16	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.17	BS-5351	:	Specification for Ball valves.
2.01.18	AWWA-C-504	:	Specification for Butterfly valves.
2.01.19	AWWA-C-208	:	Dimension for fabricated steel water pipe fittings.

2.02.00 Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Purchaser.

3.00.00 **SCOPE OF WORK**

3.01.00 The equipment and materials to be supplied shall include but not be limited to the following:

a) Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.

b) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.

c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.

d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the entire low pressure piping system.

e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.

f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.

g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.

h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings.

i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

3.02.00 Following general requirements shall however be provided

a) Instrument Connections including instruments, root valves, sensing lines etc.

b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments

4.00.00 GENERAL DESIGN AND CONSTRUCTION

4.01.00 General Considerations

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship.

4.01.03 All design and fabrication shall be in accordance with codes/standards specified.

4.01.04 No pipe work shall be run in trenches carrying electrical cables.

4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.

4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.

4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.

4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.

4.01.09 **Drain Pipe Work**

a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.

b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.

c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.

4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I.

4.02.00 **Material Specification**

4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.

4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes, shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = 1.5 x pipe diameter) wherever required shall be provided.

4.03.04 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

4.03.05 Cutting and Bevelling

a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.

b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**

4.05.01 General Requirements

a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III. In general all pumps (other than sump pumps), discharge valves shall be motor operated only. Tank inlet valves shall be motor operated only.

b) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.

c) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.

d) All valves shall receive tests at manufacturer's or contractor's works in accordance with the specific requirements of the approved Codes of Practice. Valves shall be rising stem or otherwise as approved by the Purchaser.

e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.

g) Check valves have been specified in order to prevent reverse flow through them.

h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.

i) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.

j) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.

k) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.

l) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.

m) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.

n) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:

   i) Hand wheel with embossed open and shut directions.
   ii) Local position indicator.
   iii) Motorised operation as specified by Engineer.

o) Gate valves, in addition shall be provided with following extra features

   i) Bypass valve for larger valves

   ii) Draining arrangement

   iii) Enclosed Gear operators for valves 300 mm size and above for ease in operation.

   iv) Motorised operation as specified by Engineer.

p) All gate and globe valves shall be rising stem type.

q) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.

r) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.

s) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.

t) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.

u) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

v) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

w) Plastic or bakelite valve hand wheels will not be accepted.

x) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.

y) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.

z) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.

aa) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

bb) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.

cc) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves refer Annexure-II & III.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 **Hosepipe and Accessories**

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

a) The water hose shall be as per IS-444 (Type-3).

b) Length of each hose shall be 15 metres.

c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 Hose pipes with fittings for Compressed air System

a) The compressed air hose shall be as per IS-911 (Type 2).

b) The length and type of each end shall be similar to as specified in above clause no. (4.07.02) above.

5.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**

5.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume : IIA with the offer.

5.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.

5.01.02 A complete list of all valves with their type, quantities & ratings.

5.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.

5.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.

5.02.00 **After Award of Contract**

Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.

5.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.

5.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.

5.02.03 Wiring diagram for all limit switches of motor operated valves.

5.02.04 The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.

6.00.00 **BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF LP PIPING**

6.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

6.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered

part of work and is required to carry out such work as per instruction of Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

6.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.

6.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.

6.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre-commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.

6.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.

6.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.

6.08.00 No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Contractor shall take prior approval from Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.

6.9.00

a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.

b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.

c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Engineer. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

d) Overhead piping shall have a minimum overhead clearance of 4 meters above walkways and working areas and 7 meters above roadways unless otherwise approved by the Engineer.

e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

6.10.00 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Contractor.

ANNEXURE-I

SPECIFICATION OF PIPES FOR DIFFERENT SERVICES

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
1.00.00 Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.		Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736		Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
2.00.00 Construction	ERW / Seamless		ERW / Seamless		ERW	ERW
3.00.00 Joints	Slip-on Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.		Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.		Socket welded for size 50 NB and below	Slip-on flange and butt weld joint.
4.00.00 Fittings	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB		

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
4.01.00 Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS-4736	ASTM-A-182 F304	ASTM-A-351-CF8
4.02.00 Construction	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
4.03.00 Standard	ANSI-B-16.9 for fabricated fitting AWWA-C-208	ANSI-B-16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
4.04.00 End details	Pipe size >=65mm NB Butt welded as per ANSI-B-16.25	Pipe size <=50 mm NB Socket welded as per ANSI-B-16.11	Pipe size >=65 mm NB Screwed Flanged	Sizes <=50 mm Screwed socketed as per ANSI-B-16.11All fittings shall be galvanized.	Socket welded	Slip - on flanges

	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
5.00.00 Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised-complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS:1239 shall be hydrostatically tested according to the said code, for others refer Section-V, Vol.: II-A.				

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i) ii) iii) iv)	Service Water Clarified Water Drinking/ Potable Water Inhibited Demineralised Water	For sizes 65mm NB and above.
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i) ii) iii)	For Demineralised water Potable/ Drinking Water Service and Instrument Air	For all sizes For sizes less than and equal to 50 mm NB For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i) ii)	Clarified Water Inhibited Demineralised Water for DMCW system	For sizes less than and equal to 50 mm NB
D.	Cast Iron body butterfly valve	i) ii) iii) iv) v)	For Demineralised Water Raw water Clarified Water Filtered Water Inhibited Demineralised Water for DMCW system	For butterfly valve specification refer Annexure II, Sec.IV of Vol. IIIE. For DM water line rubber lining/ EPDM/equivalent protection to be provided

ANNEXURE-III

SPECIFICATION OF VALVES

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
1.00.00	Valve Classification Code	CIGC	SSGC	STGC
2.00.00	Basic Design Code			
	a) Gate	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm ii) API 602 for size
	b) Globe	b) MSS - SP - 85		b) BS-1873/ANSI-B-16.34
	c) Check	c) IS-5312/MSS - SP -71		c) BS-1868/ANSI B16.34
	d) Ball		d) BS-5351	
3.00.00	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.00.00	Construction	Cast body and bonnet / cover	Forged body up to 50mm NB and Cast body above that	Same as Group-B
5.00.00	Material			
5.01.00	Body & Bonnet/ cover	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8M for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
5.02.00	Trim / Disc.	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves. For DKW system : ASTM-A-182 F6A (min. 250 HB)	13% Cr Steel as per ASTM-A-182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
5.03.00	Seating surface	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A-182 Gr. F6
6.00.00	End Preparation	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB		API-598
		ii) IS-2906 for sizes equal to and above 350 mm NB	As per ANSI B-16.34	
	b) Globe	Hydrostatic Test as per MSS-SP-85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868

VOLUME : IIIF

SECTION-III

MISCELLANEOUS HOISTS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL INFORMATION
2.00.00	CODES AND STANDARDS
3.00.00	SCOPE OF WORK
4.00.00	SPECIFIC DESIGN REQUIREMENTS
5.00.00	DESIGN AND CONSTRUCTION
6.00.00	INSPECTION AND TESTING
7.00.00	DRAWINGS, DATA AND INFORMATION

ATTACHMENT

ANNEXURE-I	LIST OF LOCATION FOR MONORAIL HOISTS

VOLUME : IIIF

SECTION-III

MISCELLANEOUS HOISTS

1.00.00 **GENERAL INFORMATION**

1.01.00 The hoists will be used for erection and maintenance of various equipment in different buildings.

1.02.00 Hoists are divided into two separate groups - (a) Hand operated and (b) Electric operated.

2.00.00 **CODES AND STANDARDS**

The design, manufacture and testing of the equipment covered under this specification shall conform to the latest editions of the following Indian Standards:

2.01.00	IS : 3832	:	Specification for Hand Operated Chain Pulley-blocks.
2.02.00	IS : 807	:	Code of Practice for Design, Manufacture, Erection and Testing (Structural Portion) of Cranes and Hoists.
2.03.00	IS : 6216	:	Short link Chain, Grade T(8) for Pulley-blocks & other Lifting Appliances.
2.04.00	IS : 4164	:	Lifting 'C' Hooks with Eye Capacity upto 25 tonnes.
2.05.00	IS : 2429 (part -I)	:	Non-calibrated Load Chain for Lifting Purposes.
2.06.00	IS : 3938	:	Specification for Electric Wire Rope Hoists. and other Indian Standards referred to in the above standards.

3.00.00 **SCOPE OF WORK**

3.01.00 Hoists shall be provided in all areas where any equipment/component weighing above 500 kg is installed and needs to be handled for maintenance purposes. Number of monorail beams shall be such that the centre line of the hoist and the centre line of equipment to be handled shall be not more than 500 mm.

3.01.01 The location and no. of hoists is to be finalised during detailed engineering. Final arrangement is subject to approval of Owner/Consultant.

3.01.02 Monorail hoists shall at least be provided in the areas mentioned in Annexure-I. The list is indicative only and not an exhaustive one.

3.02.00 All drive motors and driving gears as necessary.

3.03.00 Limit switches for electrical hoist as necessary.

3.04.00 Trailing cable with all supporting fixtures as necessary for electric hoists.

3.05.00 Pendent control station with all accessories for electric hoists.

3.06.00 Lifting lug, eye bolts etc., for handling hoist parts.

3.07.00 Protection guard as specified.

3.08.00 Lifting hook block assembly for hoists.

4.00.00 **SPECIFIC DESIGN REQUIREMENTS**

4.01.00 Lifting capacity

4.01.01 Capacity of each hoist shall be 1.2 times the maximum working load.

4.01.02 Hoists of capacity upto 5 tones shall be manual hoists.

Hoists of capacity above 5 tones shall be electric hoists.

4.02.00 **Effort for Mechanical Hoists**

4.02.01 Hoisting

Hoisting effort for hoists upto 3 tones capacity shall not be more than 20 kg.

Hoisting effort for hoists above 3 tones capacity shall not be more than 25 kg

4.02.02 Trolley Motion

Effort for trolley motion for hoists upto 3 tones capacity shall not be more than 15 kg.

Effort for trolley motion for hoists above 3 tones capacity shall not be more than 20 Kg.

4.02.03 For Electric operated hoist both hoisting and trolley motion shall be motor operated.

4.03.00 **Lift**

4.03.01 Lift above operating floor

Highest position of the hook shall be such that during operation of hoists, the vertical distance between bottom of any equipment handled and top of any permanent structure or equipment in the operating area shall be at least one metre.

4.03.02 Approach below operating floor

To be decided by the Bidder for safe and reliable handling of any equipment above half ton below the operating floor.

4.04.00 **Length of Monorail Hoist**

To be decided by the Bidder depending on the floor and machine layout. The horizontal distance between the centre line of the hoist and centre line of any installed equipment in its operating shall not be more than half metre.

5.00.00 **DESIGN AND CONSTRUCTION**

5.01.00 All parts requiring replacement or lubrication shall be easily accessible without the need for dismantling of other equipment and structures.

Robust construction and ample rating merging which experience has shown to be necessary shall be ensured throughout manufacture.

5.02.00 All components of hoists of identical capacity and duty shall be interchangeable. The hoists of identical capacity and duty shall be identical in all respects unless otherwise required. The hoist design shall be such that these can be quickly removed from one monorail beam and fixed on another beam without disassembling major components.

5.03.00 All machinery and equipment included under this specification must be equipped with safety devices and clearances to comply with recognized standards and specification requirements.

5.04.00 Cast iron parts wherever used, shall conform to IS:210 - FG 260. Also no wood or other combustible materials shall be used.

5.05.00 Defects in material like fractures, cracks, blowholes, laminations, pitting etc. are not allowed. Rectifications of any such flaw is permissible only with the approval of the Purchaser.

5.06.00 Each hoist shall be permanently and legibly stamped with the tag number, manufacturer's name, safe working load, grade of load chain (where applicable), range of lift etc.

5.07.00 Load chain (where applicable) shall be of grade T(8) as per IS:6216 and Hand chain shall be as per IS:2429 (Part-I) grade 30.

5.08.00 Wheels in trolley unit travel shall be single flanged with straight/tapper/barrel shaped tread to suit the monorail. Wheels should be preferably of forged steel construction. Material of construction for wheels of traversing block and hoist gear for hoist used in hazardous areas shall be of non-ferrous material to avoid spark during operation.

5.09.00 All gears shall be hardened and tempered steel with machine out teeth.

5.10.00 **Hoist (Manually Operated)**

5.10.01 Manually operated hoists shall be of spur gear chain pulley block type. It shall be suspended from the trolley by a hook. The design of the hoist shall conform to IS:3832 (Specification for hand operated chain pulley blocks). The hooks and brakes of hoist shall conform to the requirements stipulated in (a) and (b) below

a) Hooks shall conform to and IS:3832. The load hook shall be swievelling type fitted with a locking device.

b) The pulley blocks shall be fitted with an automatic mechanical load brake to prevent self lowering of load in all working positions. The load brake shall also allow smooth lowering of load without serious overheating.

c) All manually operated hoists, unless stated otherwise, shall be trolley suspended type.

5.10.02 The trolley of hoists shall be manually operated.

5.10.03 The hoists shall be of Mechanism class 2 as per IS:3832.

5.11.00 **Electric Hoist**

5.11.01 Electric hoist shall be electric wire rope trolley suspended type. The design, operation, testing of electric hoist shall conform to IS:3938 (Specification for electric wire rope hoist).

Minimum speed for hoisting shall be 3 m/min. and that of for trolley motion shall be 15 m/min.

5.11.02 Lifting hook shall conform to IS-4164 as applicable.

5.11.03 Wire rope for hoists shall conform to IS-2266.

5.11.04 Electro-mechanical brakes of fail to safety type shall be provided for hoist motion as well as per trolley motion for electrically driven trolley. Load brake shall allow smooth lowering of load and arrangement shall be such as it can not be released accidentally. Capacity of brake and other relevant data shall conform to IS:3938.

5.11.05 The trolley of the hoists shall be electrically driven.

5.11.06 For other components of hoist such as rope, sheave, drum, bearings, gears etc. stipulations of IS: 3938 shall be followed.

5.11.07 Motor shall be rated for duty S4. Service class of motor shall be "M8" as per IS:3177. Conditions given in IS:3938 for hoist motor shall be followed over and above the specification of electric motor in Volume-V. In case of any contradiction of the aforesaid standard and the motor specification, the conditions which are more stringent shall be considered. All the motors shall be suitable for reversing, frequent starting and braking. Motors shall be provided with suitable space heating arrangement.

5.11.08 Hoist shall be designed so that remote control can be effected by means of pendant push button switch from the operating floor. Operation, arrangement etc. of pendant push button switch shall conform to IS:3938.

5.11.09 Micro-speed attachment in hoist shall be provided if considered necessary by the Bidder.

5.11.10 The hoists shall be of mechanism class 2 as per IS-3938.

5.12.00 Ball and roller bearings of reputed make shall be used throughout.

5.13.00 Suitable lubrication system shall be provided for all gear drives.

5.14.00 **Other Electrical Items**

5.14.01 The cross conductor on monorail for power supply to the hoist shall be of festoon type flexible insulated cable conductors. All fixtures and accessories shall be provided by the Bidder for this purpose.

5.14.02 Necessary insulators, supports, clamps and all other accessories shall be provided as per standard design.

5.14.03 Each hoist shall be provided with a starter panel with protective relays.

5.14.04 One main isolating switch shall be used to cut-off the supply to the hoist assembly.

5.14.05 One main electro-magnetic contactor together with magnetic overload relay (hand reset) for each motor circuit shall be housed in the protection panel.

5.14.06 The operation of overload relay shall interrupt the main magnetic contactor.

5.14.07 Adequate short circuit protection shall be provided for main and individual circuits.

5.14.08 415V ± 10%, 3 Phase, 4 Wire, 50 Hz ± 5%, power supply for the hoist shall be arranged through MCCB unit mounted at standing height at a convenient location near each hoist.

5.14.09 Transformers to step down the voltage and rectifiers as necessary shall be provided by the Bidder.

5.14.10 All external and internal power, control and auxiliary circuit wiring of the electrical drive and accessories and panels shall be provided. The wiring shall be done with 1100 V grade PVC insulated stranded aluminium conductor cable of suitable size not less than 2.5 sq.mm nominal equivalent copper area of cross-section. All control and auxiliary circuit wiring shall be done with 1100 V grade PVC insulated, 2.5 sq.mm stranded copper conductor. Control wire terminations to the panels shall be made with compression type connectors. Multiway terminal blocks shall be furnished for terminating panel wiring and outgoing cable.

5.14.11 The hoist structure, motor frame and metal cases of all electrical equipment including metal conduit shall be effectively connected to earth. All grounding materials shall be supplied under this specification to grounding risers.

5.14.12 Single speed control shall be used for both hoist and trolley travel in each direction of motion.

6.00.00 INSPECTION AND TESTING

6.01.00 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of the specification and in compliance with the requirements of the latest edition of IS:3832 or equivalent standards for manually operated hoists and shall be as per IS:3938 for electrically operated hoist.

6.02.00 All the mono-rail hoists shall also be tested at site as per the stipulation of relevant Indian Standards.

7.00.00 DRAWINGS, DATA AND INFORMATION

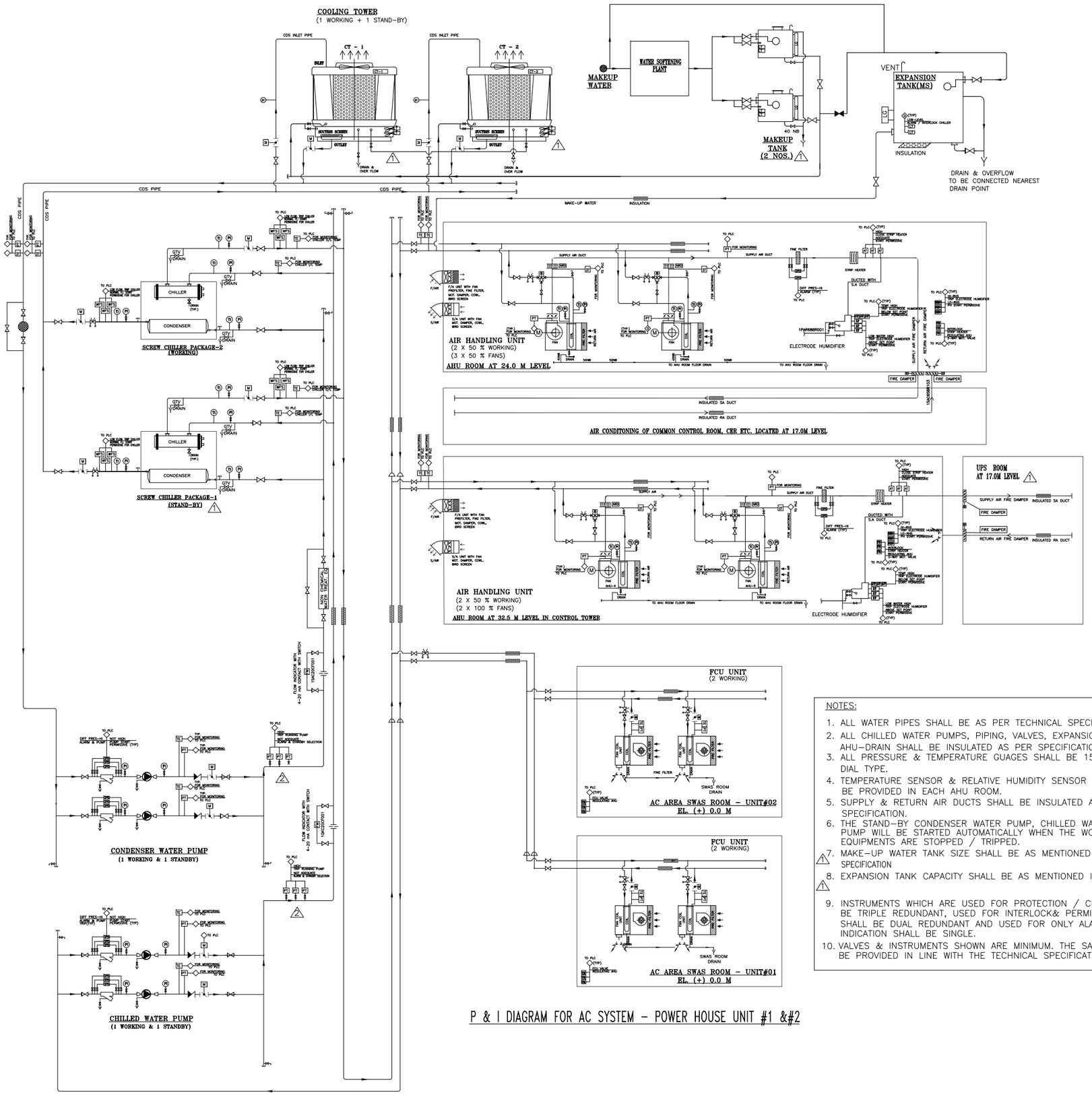
7.01.00 General arrangement drawings incorporating all dimensions information on head rooms, lift, wheel loads, hook suspension arrangement and other relevant data for all the hoists.

7.02.00 For Mandatory Spares, Spares required for erection and commissioning, Recommended Spares, Special Tools And Tackles, fixtures etc., as required for regular operation and maintenance of the equipment offered and supply of first charge of lubricating oil, inhibitor oil and also adequate quantity of the consumables, please refer Technical Specification Volume-II A.

7.03.00 Design calculation for selection of electric motor capacities for electric hoist.

7.04.00 Complete list of location, number and capacity of hoists provided.

ANNEXURE-A: P&I DIAGRAM FOR AC PLANT (5 SHEETS)



P & I DIAGRAM FOR AC SYSTEM – POWER HOUSE UNIT #1 &#2

REFERENCE DOCUMENT/DRAWING	
REFERENCE DOCUMENT/DRAWING	REFERENCE DOCUMENT/DRAWING TITLE
PE-DG-417-100-M003	TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT EL 0.0M)
PE-DG-417-100-M004	TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT EL 8.5M)
PE-DG-417-100-M005	TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT EL 17.0M)
PE-DG-417-100-M006	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS ABOVE OPERATING FLOOR IN BC BAY.
PE-DG-417-100-M007	CROSS SECTION OF MAIN PLANT (TG BUILDING)

LEGEND

SYMBOL	DESCRIPTION	TAG	SYMBOL	DESCRIPTION	TAG
	TEMPERATURE GAUGE	TI		NON RETURN VALVE	NRV
	PRESSURE GAUGE	PI		Y-STRAINER	YSTR
	BALANCING VALVE	BV		GATE VALVE	GV
	MOTORISED BUTTERFLY VALVE	MBF		NON RETURN DAMPER	NRD
	3-WAY MOTORISED MIXING VALVE	3MV		FIRE DAMPER (MOTOR OPERATED)	FD
	PUMP	P		VOLUME CONTROL DAMPER.	VCD
	VENT VALVE	–		LEVEL TRANSMITTER	LT
	PURGE VALVE.	–	T	DESCALING TEE	–
WFS	WATER FLOW SWITCH	WFS	AT	AIRSTAT	AT
	PRE FILTER	–		FIRE DAMPER (MOTOR OPERATED)	FD
	FINE FILTER	–		FINNED TYPE STRIP HEATER	–
	HEPA FILTER	–	GT	GEYSER THERMOSTAT	GT
–E–	ELECTRICAL LINE	E	HLS	HIGH LEVEL SWITCH	HLS
PH	ELECTRODE HUMIDIFIER	PH	PX	PRESSURE TEST POINT	PX
LLS	LOW LEVEL SWITCH	LLS	TE	TEMPERATURE ELEMENT	TE
TX	TEMP. TEST POINT	TX	RHS	HUMIDITY SENSOR	RHS
DPS	DIFFERENTIAL PRESSURE SWITCH	DPS	WPS	WATER LINE PRESSURE SWITCH	WPS
TS	TEMPERATURE SENSOR	TS	PS	AIR LINE PRESSURE SWITCH	PS
	POT STRAINER	–	HLS	HIGH LEVEL SWITCH	HLS
PT	PRESSURE TRANSMITTER	PT		SIGNAL TO DCS	
TE	TEMPERATURE ELEMENT	TE			
				CONDENSER WATER LINE	
				CHILLED WATER LINE	
				SUPPLY AND RETURN AIR DUCT	

NOTES:

1. ALL WATER PIPES SHALL BE AS PER TECHNICAL SPECIFICATION.
2. ALL CHILLED WATER PUMPS, PIPING, VALVES, EXPANSION TANK AHU-DRAIN SHALL BE INSULATED AS PER SPECIFICATION.
3. ALL PRESSURE & TEMPERATURE GUAGES SHALL BE 150MM DIAL TYPE.
4. TEMPERATURE SENSOR & RELATIVE HUMIDITY SENSOR SHALL BE PROVIDED IN EACH AHU ROOM.
5. SUPPLY & RETURN AIR DUCTS SHALL BE INSULATED AS PER SPECIFICATION.
6. THE STAND-BY CONDENSER WATER PUMP, CHILLED WATER PUMP WILL BE STARTED AUTOMATICALLY WHEN THE WORKING EQUIPMENTS ARE STOPPED / TRIPPED.
7. MAKE-UP WATER TANK SIZE SHALL BE AS MENTIONED IN THE SPECIFICATION
8. EXPANSION TANK CAPACITY SHALL BE AS MENTIONED IN THE SPECIFICATION
9. INSTRUMENTS WHICH ARE USED FOR PROTECTION / CLCS SHALL BE TRIPLE REDUNDANT, USED FOR INTERLOCK& PERMISSIVE SHALL BE DUAL REDUNDANT AND USED FOR ONLY ALARM OR INDICATION SHALL BE SINGLE.
10. VALVES & INSTRUMENTS SHOWN ARE MINIMUM. THE SAME SHALL BE PROVIDED IN LINE WITH THE TECHNICAL SPECIFICATION.
10. ALL DRAIN LINES SHALL BE TERMINATED AT NEARES FLOOR DRAINS.
11. KKS TAGGING SHALL BE PROVIDED FOR FOR EQUIPMENTS, INSTRUMENTS VALVES AND PIPES. FOR KKS TAGGING PHILOSOPHY PLEASE REFER DETAIL IN SUBSEQUENT SHEETS.
12. INCASE OF SKID MOUNTED INSTRUMENTS, IF IT IS NOT POSSIBLE TO PROVIDE REDUNDANCY IN INSTRUMENTS, THE REDUNDANT INSTRUMENTS SHALL PROVIDED AS LOOSE SUPPLY ITEM TO BHEL.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

JOB NO. 417
STATUS CONTRACT
DISTRIBUTION

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POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
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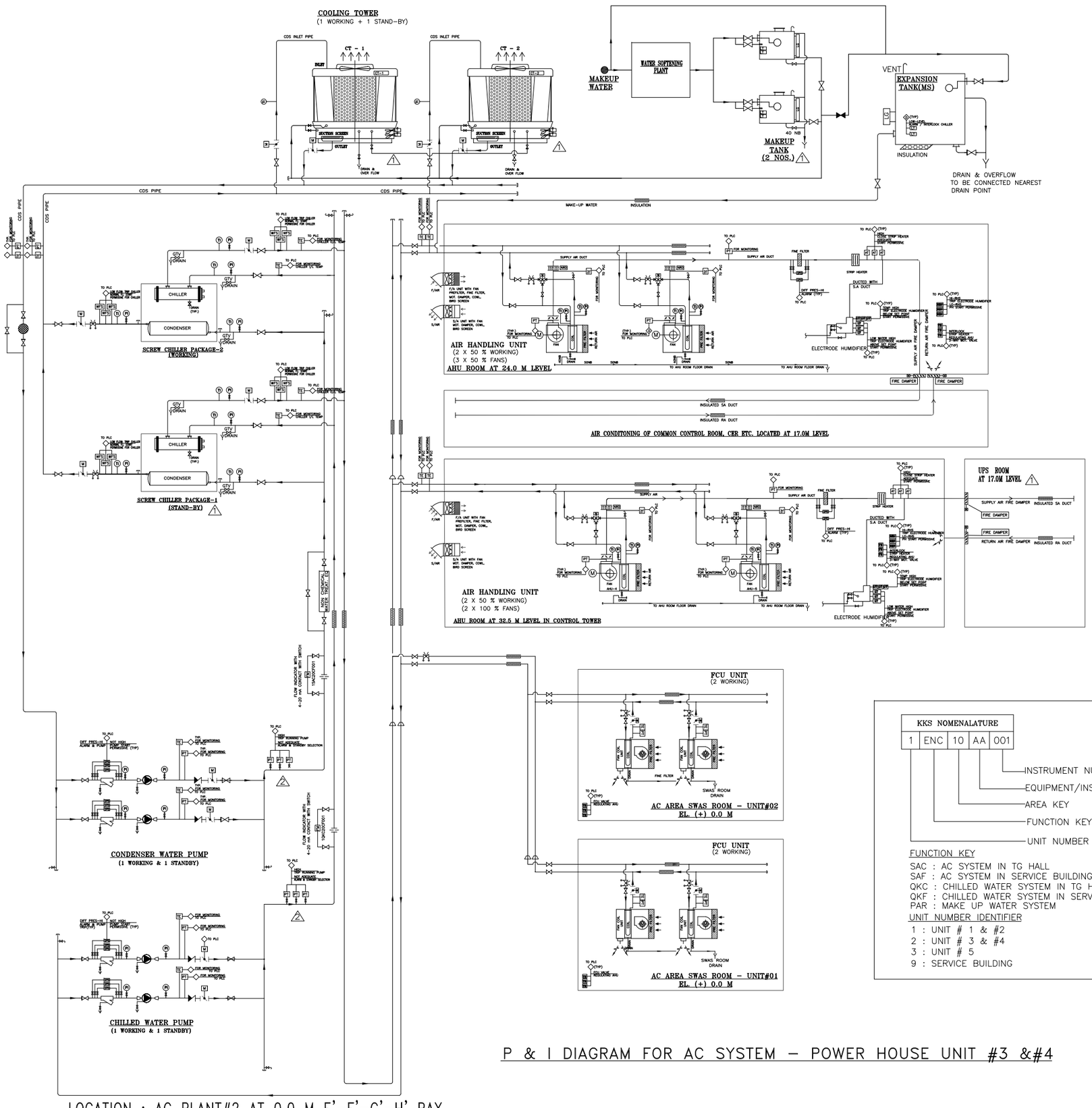
TITLE: P & I DIAGRAM FOR AC SYSTEM – POWER HOUSE UNIT #1 & #2

DEPT. M | SCALE | DRAWING NO. PE-DG-417-553-A001 | SHEET 1 OF 5 | REV. 2 | SIZE-A0

REFERENCE DOCUMENT/DRAWING	
REFERENCE DOCUMENT/DRAWING	REFERENCE DOCUMENT/DRAWING TITLE
PE-DG-417-100-M003	TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT EL 0.0M)
PE-DG-417-100-M004	TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT EL 8.5M)
PE-DG-417-100-M005	TG EQUIPMENT LAYOUT DRAWING AT GROUND FLOOR (AT EL 17.0M)
PE-DG-417-100-M006	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS ABOVE OPERATING FLOOR IN BC BAY
PE-DG-417-100-M007	CROSS SECTION OF MAIN PLANT (TG BUILDING)



KKS NOMENALATURE				
1	ENC	10	AA	001

- 001 — INSTRUMENT NUMBER KEY
- AA — EQUIPMENT/INSTRUMENT KEY
- 10 — AREA KEY
- ENC — FUNCTION KEY
- 1 — UNIT NUMBER IDENTIFIER

FUNCTION KEY

SAC : AC SYSTEM IN TG HALL
SAF : AC SYSTEM IN SERVICE BUILDING
QKC : CHILLED WATER SYSTEM IN TG HALL
QKF : CHILLED WATER SYSTEM IN SERVICE BUILDING
PAR : MAKE UP WATER SYSTEM

UNIT NUMBER IDENTIFIER

1 : UNIT # 1 & #2
2 : UNIT # 3 & #4
3 : UNIT # 5
9 : SERVICE BUILDING

NOTES:

1. FOR NOTES AND LEGENDS REFER SHEET 1 OF 5

P & I DIAGRAM FOR AC SYSTEM – POWER HOUSE UNIT #3 &#4

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

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TITLE: P & I DIAGRAM FOR AC SYSTEM – POWER HOUSE UNIT #3 & #4

DRAWING NO. PE-DG-417-553-A001
SHEET 2 OF 5 REV. 2
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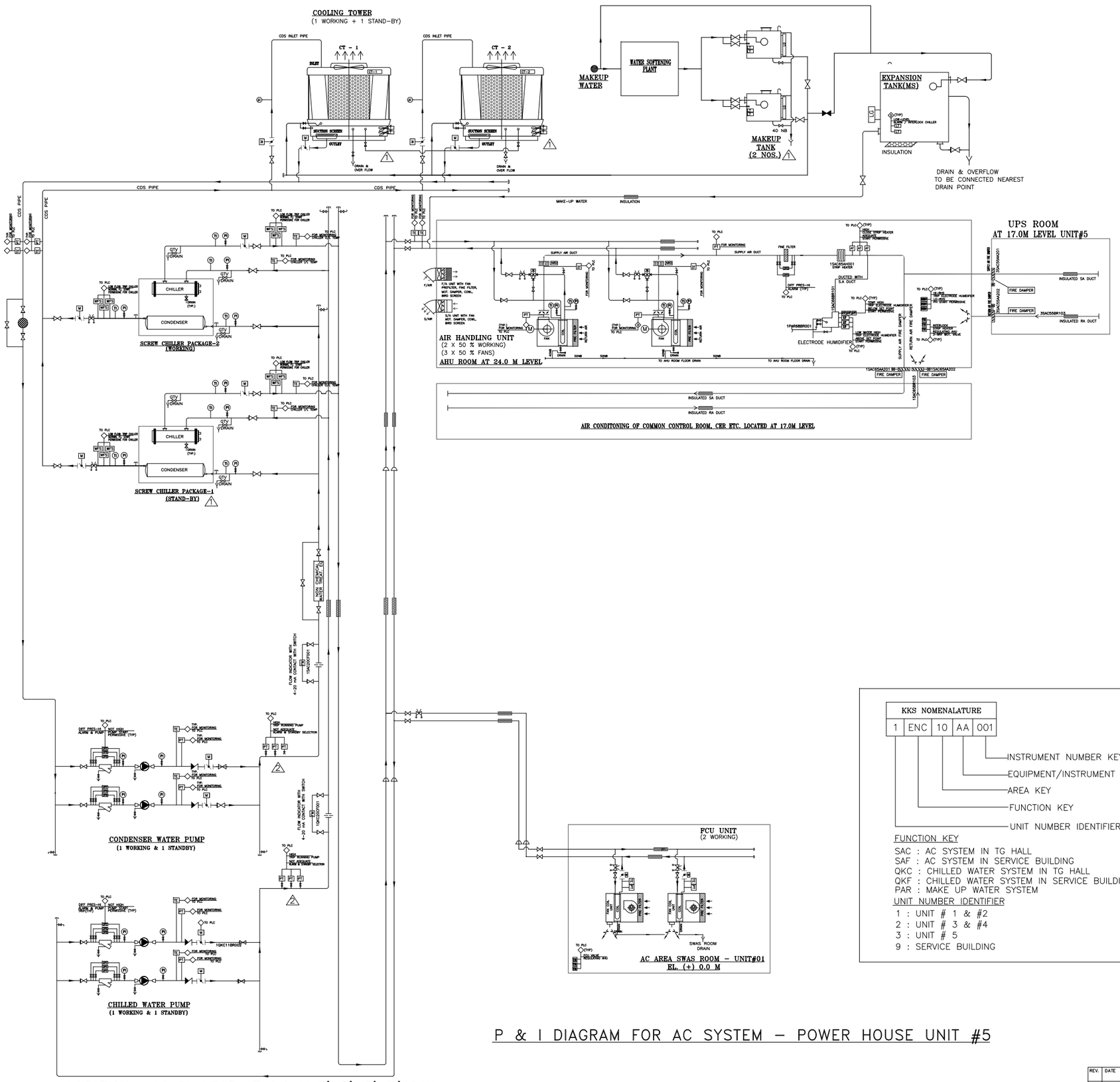
PE-DG-417-100-M007	CROSS SECTION OF MAIN PLANT (TG BUILDING)



KKS NOMENALATURE				
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FUNCTION KEY

SAC : AC SYSTEM IN TG HALL
SAF : AC SYSTEM IN SERVICE BUILDING
QKC : CHILLED WATER SYSTEM IN TG HALL
QKF : CHILLED WATER SYSTEM IN SERVICE BUILDING
PAR : MAKE UP WATER SYSTEM

UNIT NUMBER IDENTIFIER

1 : UNIT # 1 & #2
2 : UNIT # 3 & #4
3 : UNIT # 5
9 : SERVICE BUILDING

NOTES:

1. FOR NOTES AND LEGENDS REFER SHEET 1 OF 5

P & I DIAGRAM FOR AC SYSTEM – POWER HOUSE UNIT #5

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

BHARAT HEAVY ELECTRICALS LTD
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TITLE
P & I DIAGRAM FOR AC SYSTEM – POWER HOUSE UNIT #5

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SIGN | SHEET 3 OF 5 | REV. 2
SIZE-A0

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

DRAWING NO.

CUSTOMER'S DRAWING NO.

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PE-DG-417-100-M006	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS ABOVE OPERATING FLOOR IN BC BAY.
PE-DG-417-100-M007	CROSS SECTION OF MAIN PLANT (TG BUILDING)

SCHEME IS TYPICAL FOR SERVICE BUILDING #1 & 2

COOLING TOWER
(1 WORKING + 1 STAND-BY)

CT - 1

CT - 2

CDS INLET PIPE

INLET

SUCTION SCREEN

OUTLET

DRAIN & OVER FLOW

MAKEUP WATER

WATER SOFTENING PLANT

MAKEUP TANK (2 NOS.)

40 NB

EXPANSION TANK(MS)

INSULATION

DRAIN & OVERFLOW TO BE CONNECTED NEAREST DRAIN POINT

CDS PIPE

MAKE-UP WATER

SCREW CHILLER PACKAGE-2 (WORKING)

SCREW CHILLER PACKAGE-1 (STAND-BY)

CHILLER

CONDENSER

CTV DRAIN

MDCT CHEMICAL WATER TREATMENT

FLOW INDICATOR WITH 4-20 mA CONTACT WITH SWITCH

CONDENSER WATER PUMP
(1 WORKING & 1 STANDBY)

CHILLED WATER PUMP
(1 WORKING & 1 STANDBY)

AIR HANDLING UNIT
(2 X 50 % WORKING)

AHU ROOM AT GROUND FLOOR

AHU ROOM AT FIRST FLOOR

AHU ROOM AT 2ND FLOOR

AHU ROOM AT 3RD FLOOR

AHU ROOM AT 4TH FLOOR

F/A UNIT WITH FAN PREFILTER, FINE FILTER, MOT. DAMPER, COIL, BIRD SCREEN

SUPPLY AIR DUCT

FINE FILTER

STRIP HEATER

DUCTED WITH S.A DUCT

ELECTRODE HUMIDIFIER

SUPPLY AIR FIRE DAMPER

RETURN AIR FIRE DAMPER

TO AHU ROOM FLOOR DRAIN

SERVICE BUILDING FOURTH FLOOR

SERVICE BUILDING THIRD FLOOR

SERVICE BUILDING SECOND FLOOR

SERVICE BUILDING FIRST FLOOR

SERVICE BUILDING GROUND FLOOR

SUPPLY AIR FIRE DAMPER INSULATED SA DUCT

FIRE DAMPER

RETURN AIR FIRE DAMPER INSULATED RA DUCT

NOTES:

1. FOR NOTES AND LEGENDS REFER SHEET 1 OF 5

LOCATION : AC PLANT#4 & 5 AT 0.0 M OF SERVICE BUILDING # 1 & 2

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CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

BHARAT HEAVY ELECTRICALS LTD
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TITLE
P & I DIAGRAM FOR AC SYSTEM – SERVICE BUILDING #1 & #2

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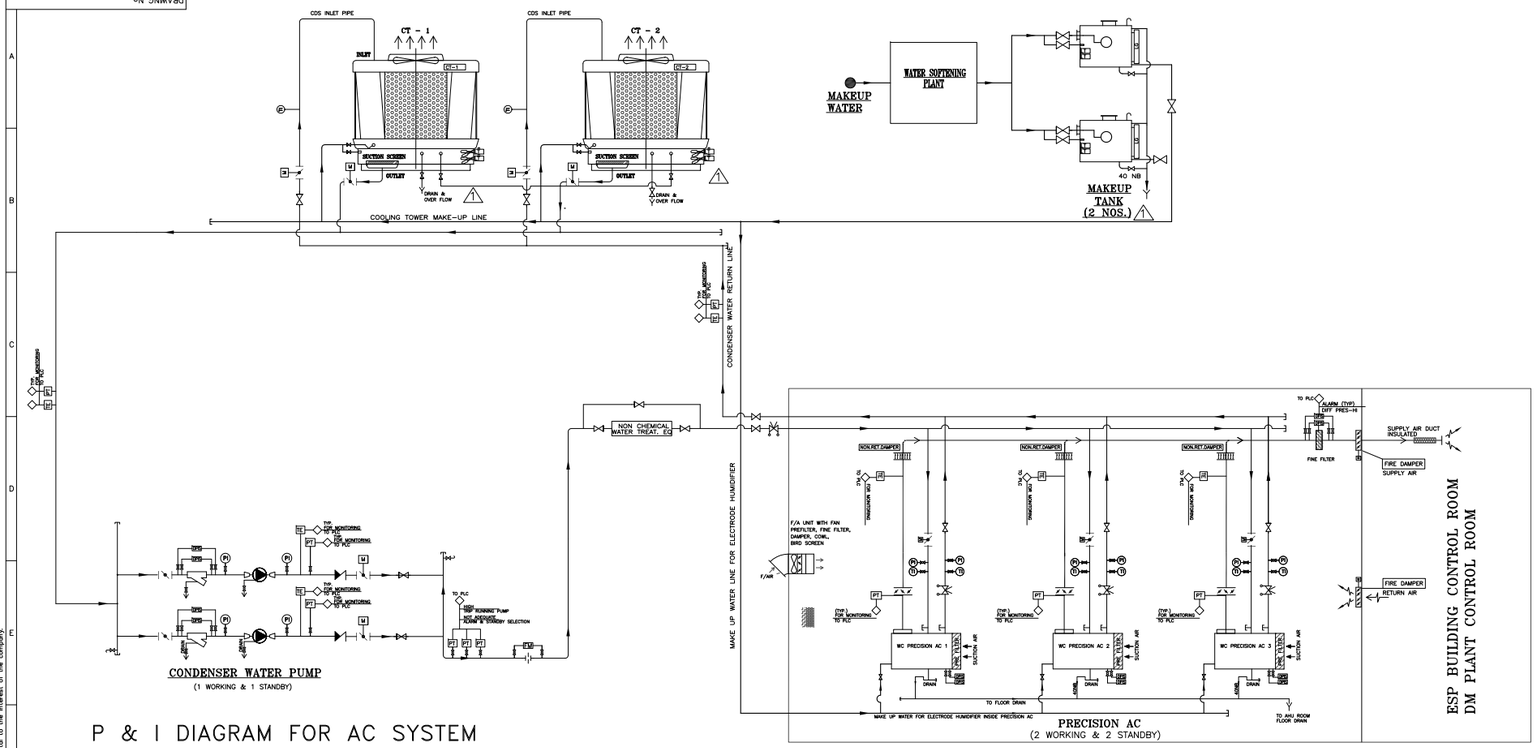
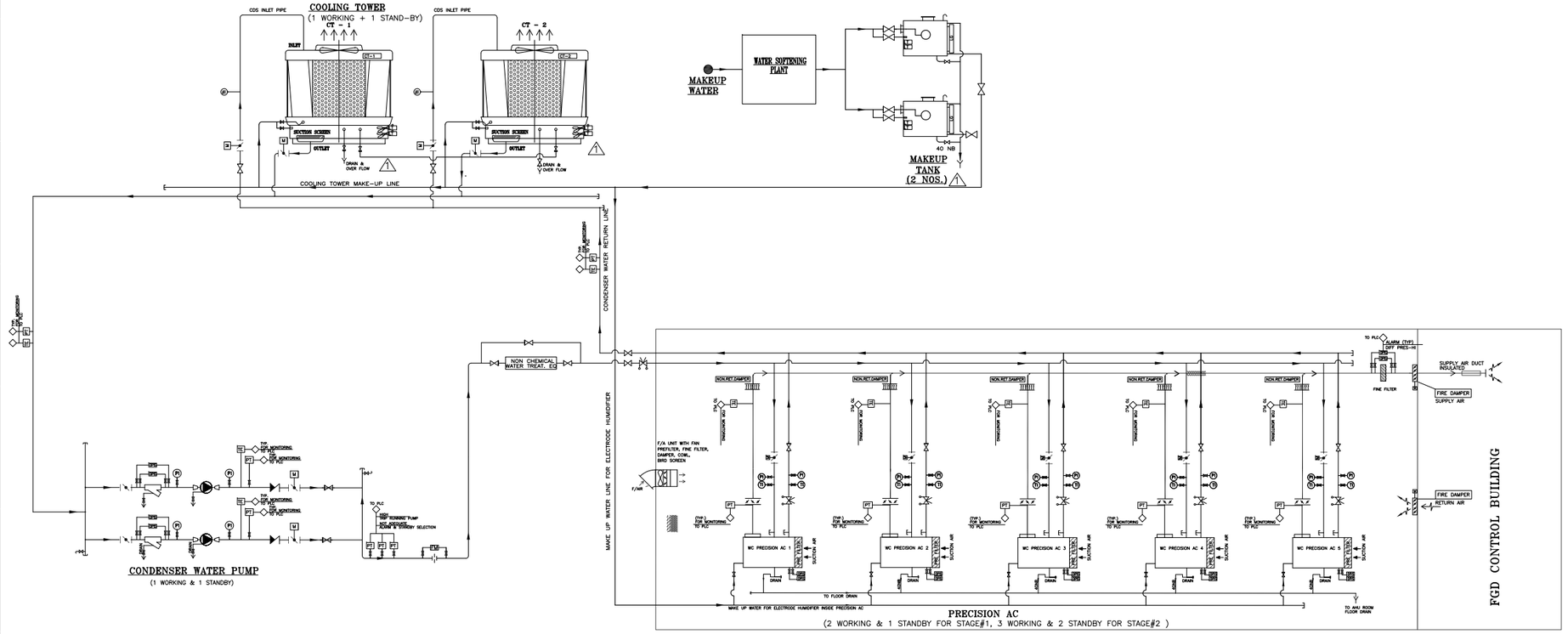


P & I DIAGRAM FOR AC SYSTEM
WATER COOLED PRECISION AC FOR ESP CONTROL BUILDING (TYP. FOR UNIT#1,2,3,4&5)
WATER COOLED PRECISION AC FOR DM PLANT CONTROL ROOM



P & I DIAGRAM FOR AC SYSTEM
WATER COOLED PRECISION AC FOR FGD CONTROL BUILDING (TYP. STAGE-I & II)

NOTES:

1. FOR NOTES AND LEGENDS REFER SHEET 1 OF 5

CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, NALGONDA
OWNER'S CONSULTANT:	TATA CONSULTING ENGINEERS LIMITED BANGALORE INDIA
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

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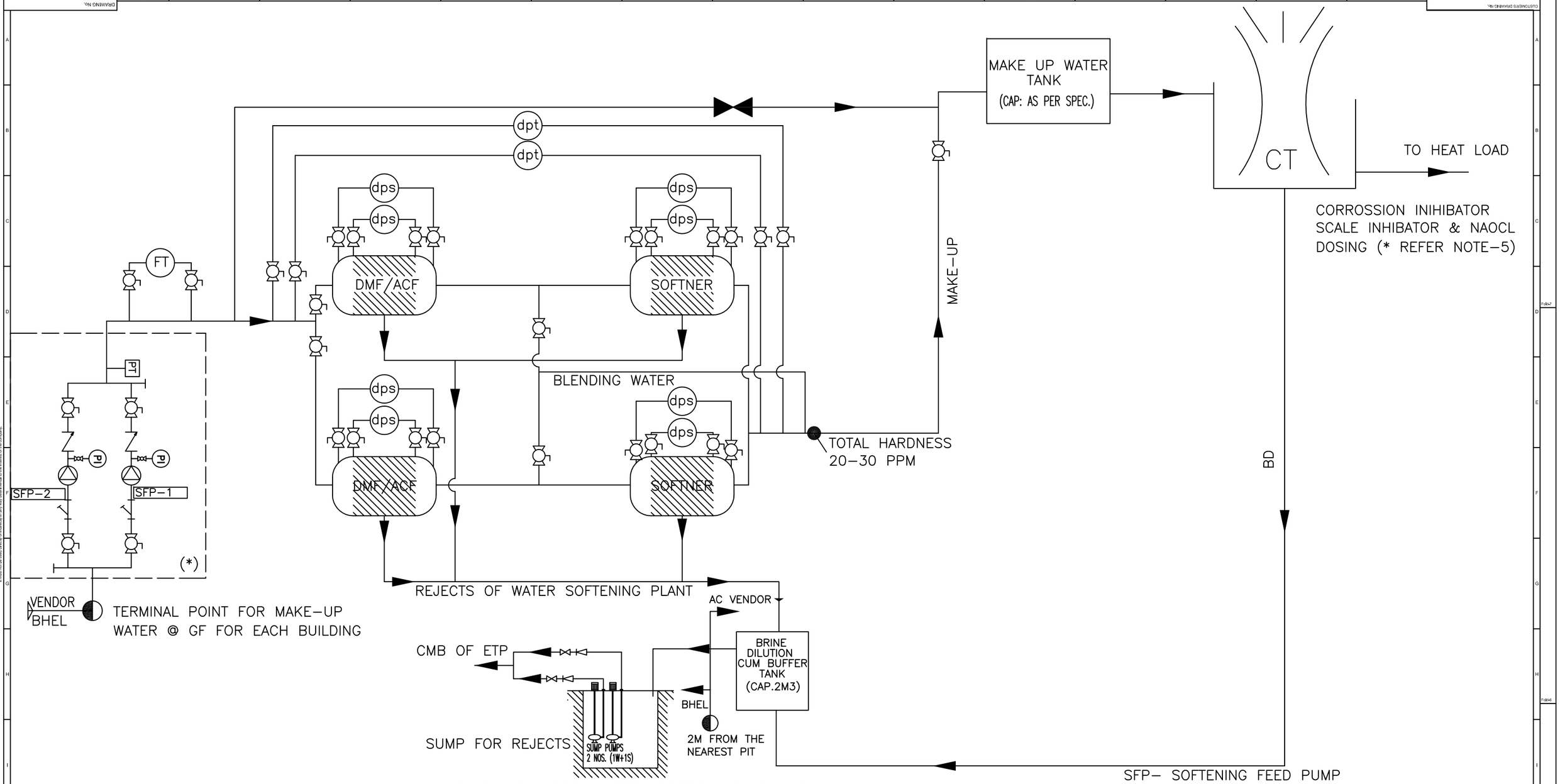
TITLE
P & I DIAGRAM FOR WATER COOLED PRECISION AC

DEPT.	SCALE	DRAWING NO.
SIGN		PE-DG-417-553-A001
		SHEET 5 OF 5 REV. 2

SIZE-A0

COMPUTER FILE NAME:



SKID MOUNTED WATER SOFTENING PLANT

(TYP. FOR POWERHOUSE UNIT# 1&2, #3&4, #5, SERVICE BUILDING#1 & #2,
ESP CONTROL BUILDING#1, #2, #3, #4, #5, DM PLANT CONTROL ROOM,
FGD MCC & CONTROL ROOM STAGE#1 &2)

SFP– SOFTENING FEED PUMP
ACF– ACTIVATED CARBON FILTER
DMF– DUAL MEDIA FILTER
BD – BLOW–DOWN
CT – COOLING TOWER
(FT) FLOW TRANSMITTER
(DPS) DIFF. PRESS. SWITCH

NOTES:

1. KKS TAGGING SHALL BE PROVIDED FOR ALL INSTRUMENTS & EQPT.
2. BD BLOW DOWN TO BE CONTROLLED TO ENSURE A CYCLE OF CONCENTRATION OF 05
3. INSTRUMENTS WHICH ARE USED FOR PROTECTION / CLCS SHALL BE TRIPLE REDUNDANT, USED FOR INTERLOCK& PERMISSIVE SHALL BE DUAL REDUNDANT AND USED FOR ONLY ALARM OR INDICATION SHALL BE SINGLE.
4. VALVES & INSTRUMENTS SHOWN ARE MINIMUM. THE SAME SHALL BE PROVIDED IN LINE WITH THE MAIN PLANT PHILOSOPHY TECHNICAL SPECIFICATION.
5. DMF/ACF FILTER MEDIA SHALL CONSIST OF GRADED QUARTZ SAND INCLUDING GRAVELS & PEBBLES (FREE FROM CARBONATES AND OTHER FOREIGN MATTER) AND ANTHRACITE AS PER REQUIREMENT.
5. SUITABLE COOLING WATER TREATMENT PROGRAM (Viz SCALE INHIBITOR/ CORROSION CORROSION INHIBITOR/BIO DISPERSANT/NAOCL ETC.) MUST TO DOSED TO MAINTAIN A CORROSION, SCALE & MICROBIOLOGICAL FOULING FREE WATER CHEMISTRY IN THE COOLING WATER CIRCUIT FOR EFFICIENT OPERATION OF AC SYSTEM.
6. MOC SHOULD BE AS PER TECHNICAL SPECIFICATION AND SHALL BE COMPATIBLE WITH THE PROCESS REQMT. & FLUID BEING HANDLED. BIDDER TO GIVE DETAILS OF IN IN SUPPORT OF THE MOC THUS SELECTED FOR SUITABILITIES OF THE MATERIAL WHEREVER NOT SPECIFIED IN THE TENDER.
7. SKID MOUNTED SOFTENING PLANT (2 X 100 %) WITH INSTRUMENTS, SOFTENING FEED PUMPS, REGENERATION PUMPS, VESSELS, BUFFER TANK , ASSOCIATED PIPING & VALVES UPTO MAKE–UP WATER TANK AND FROM MAKE–UP WATER TANK UPTO COOLING TOWER SHALL BE CONSIDERED AS A SINGLE PACKAGE. FURTHER PRICES SHALL BE QUOTED AGAINST " SKID MOUNTED SOFTENING PLANT..." MENTIONED IN PRICE SCHEDULE FOR RESPECTIVE AC PLANTS.
8. TECHNICAL GRADE OF SALT SUITABLE FOR INDUSTRIAL USE SHALL BE USED.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

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	CHD		
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TITLE: SCHEMATIC DIAGRAM OF WATER SOFTENING PLANT

DEPT. | SCALE | SIGN | DRAWING NO. PE-DG-417-553-A001 | SHEET 8 OF 8 | REV. 1 | SIZE-A0

ANNEXURE-B: MAKE WATER SCHEME

30 M^3/hr(STAGE#2)

REFER P&ID OF PLANT WATER SYSTEM:

HVAC MAKE-UP (Clarified water) FOR HVAC MAKE-UP DISTRIBUTION AT VARIOUS PLACES AND TERMINAL POINT AS SHOWN IN DRG.

POWER HOUSE #3 & #4

9 m^3/hr → BIDDER → HVAC-1 → BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF POWER HOUSE #3 &4

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL ABOVE AC PLANT OF POWERHOSE #3 &4

POWER HOUSE #5

6 m^3/hr → BIDDER → HVAC-1 → BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF POWER HOUSE #5

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL ABOVE AC PLANT OF POWERHOSE #5

9 m^3/hr → BIDDER → HVAC-2 → BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF SERVICE BLDG #2

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL ABOVE AC PLANT OF SERVICE BUILDING#2)

1.2m^3/hr → BIDDER → HVAC-3 → BHEL

ELECTRODE HUMIDIFIER
FOR WATER COOLED PRECISION AC OF ESP CONTROL ROOM #3

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF ESP CONTROL ROOM #3)

1.2m^3/hr → BIDDER → HVAC-4 → BHEL

ELECTRODE HUMIDIFIER
FOR WATER COOLED PRECISION AC OF ESP CONTROL ROOM #4

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF ESP CONTROL ROOM #4)

1.2m^3/hr → BIDDER → HVAC-4 → BHEL

ELECTRODE HUMIDIFIER
FOR WATER COOLED PRECISION AC OF ESP CONTROL ROOM #5

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF ESP CONTROL ROOM #5)

1.2m^3/hr → BIDDER → HVAC-5 → BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF FGD MCC & CONTROL ROOM #2

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF FGD MCC & CONTROL ROOM)

1.2m^3/hr → BIDDER → HVAC-5 → BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF DM PLANT CONTROL ROOM

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF DM PLANT CONTROL ROOM)

PIPE SIZE - CARBON STEEL

NB	OD (mm) MAX	THICKNESS (mm)
50	60.8	4.5
40	48.8	4
25	34.2	4

NOTE:-

1. VOID
2. HVAC MAKE-UP WATER PIPING INCLUDING FITTINGS SHALL BE TERMINATED WITHIN THE RANGE OF 5 METER DISTANCE FROM WATER SOFTENING PLANT BY BHEL.
   FURTHER PIPING SHALL BE DONE BY RESPECTIVE PLANT SUPPLIER AS MARKED IN THIS DRG.
3. HVAC MAKE-UP WATER PRESSURE at EACH TERMINAL POINT SHALL BE AVAILABLE 0.5 kg/cm2.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT:

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TITLE: SCHEMATIC DIAGRAM FOR HVAC MAKE UP STAGE-II

DRAWING NO: PE-DG-417-554-A005

SHEET 2 OF 2 REV. 0

SIZE-A0

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21.6M^3/hr (STAGE#1)

REFER P&ID OF PLANT WATER SYSTEM:

HVAC MAKE-UP (Clarified water) FOR HVAC MAKE-UP DISTRIBUTION AT VARIOUS PLACES AND TERMINAL POINT AS SHOWN IN DRG.

POWER HOUSE #1 & #2

9 m^3/hr

BIDDER

HVAC-1

BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF POWER HOUSE #1 & 2

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL ABOVE AC PLANT OF POWERHOSE #1 & 2

9 m^3/hr

BIDDER

HVAC-2

BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF SERVICE BLDG #1

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL ABOVE AC PLANT OF SERVICE BUILDING#1)

1.2m^3/hr

BIDDER

HVAC-3

BHEL

ELECTRODE HUMIDIFIER
FOR WATER COOLED PRECISION AC OF ESP CONTROL ROOM #1

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF ESP CONTROL ROOM #1)

1.2m^3/hr

BIDDER

HVAC-4

BHEL

ELECTRODE HUMIDIFIER
FOR WATER COOLED PRECISION AC OF ESP CONTROL ROOM #2

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF ESP CONTROL ROOM #2)

1.2m^3/hr

BIDDER

HVAC-5

BHEL

ELECTRODE HUMIDIFIER
FOR EACH AHU ROOM OF FGD MCC & CONTROL ROOM #1

For AC SYSTEM, NEAR MAKE-UP WATER TANK
NEAR AC SYSTEM COOLING TOWER at terrace floor OF AC-PLANT.

LOCATION : (AT ROOF/TERRACE LEVEL OF FGD MCC & CONTROL ROOM)

PIPE SIZE - CARBON STEEL

NB	OD (mm) MAX	THICKNESS (mm)
50	60.8	4.5
40	48.8	4
25	34.2	4

NOTE:-

1. FOR NOTES REFER SHEET 2 OF 2

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT:

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TITLE
SCHEMATIC DIAGRAM FOR HVAC MAKE UP STAGE-I

DEPT. | SCALE | SIGN

DRAWING NO. PE-DG-417-554-A005

SHEET 1 OF 2 | REV. 0

SIZE-A0

COMPUTER FILE NAME:

ANNEXURE-C: LOCATIONS OF AC PLANT ROOMS AND AREAS FOR AIR CONDITIONING IN THE SERVICE BUILDING, ESP BUILDING, FGD CONTROL BUILDING & POWER HOUSE.

ANNEXURE-D: SYSTEM CAPACITY AND CONFIGURATION

ANNEXURE-D : SYSTEM CAPACITY & CONFIGURATION

Sl.No.	Location/Building	Equipment configuration	Capacity (Minimum)	Remarks
1	AC-Plant-1 (TG Hall U #1 &2)	2 X 100 % water cooled screw chiller	300 TR(actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, chilled water pumps, condenser water pumps, AHU's, water softening plant, Make up water tanks, expansion tank etc. shall be sized according to the chiller capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) 2 X 50% AHU's (each AHU with 3 X 50 % centrifugal fans) shall be provided for air conditioning of the control room areas at 17M level of the main power house. c)2 X 50% AHU's (each AHU with 2 X 100 % centrifugal fans) shall be provided for air conditioning of the UPS room at 17M level of the main power house.
2	AC-Plant-2 (TG Hall U #3 &4)	2 X 100 % water cooled screw chiller	300 TR(actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, chilled water pumps, condenser water pumps, AHU's, water softening plant, Make up water tanks, expansion tank etc. shall be sized according to the chiller capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) 2 X 50% AHU's (each AHU with 3 X 50 % centrifugal fans) shall be provided for air conditioning of the control room areas at 17M level of the main power house. c)2 X 50% AHU's (each AHU with 2 X 100 % centrifugal fans) shall be provided for air conditioning of the UPS room at 17M level of the main power house.

ANNEXURE-D : SYSTEM CAPACITY & CONFIGURATION

Sl.No.	Location/Building	Equipment configuration	Capacity (Minimum)	Remarks
3	AC-Plant-3 (TG Hall U #5)	2 X 100 % water cooled screw chiller	150 TR(actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, chilled water pumps, condenser water pumps, AHU's, water softening plant, Make up water tanks, expansion tank etc. shall be sized according to the chiller capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) 2 X 50% AHU's (each AHU with 3 X 50 % centrifugal fans) shall be provided for air conditioning of the control room areas & UPS at 17M level of the main power house.
4	AC-Plant-4 (Service Building #1)	2 X 100 % water cooled screw chiller	300 TR(actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, chilled water pumps, condenser water pumps, AHU's, water softening plant, Make up water tanks, expansion tank etc. shall be sized according to the chiller capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) 2 X 50% AHU's shall be provided for air conditioning of each floor of the service building.

ANNEXURE-D : SYSTEM CAPACITY & CONFIGURATION

Sl.No.	Location/Building	Equipment configuration	Capacity (Minimum)	Remarks
5	AC-Plant-5 (Service Building #2)	2 X 100 % water cooled screw chiller	300 TR(actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, chilled water pumps, condenser water pumps, AHU's, water softening plant, Make up water tanks, expansion tank etc. shall be sized according to the chiller capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) 2 X 50% AHU's shall be provided for air conditioning of each floor of the service building.
6	AC Plant-6 (ESP Control Building -Unit # 1)	3 Nos (2W + 1S) Water cooled precision type package AC	3 X 20 TR (actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered.
7	AC Plant-7 (ESP Control Building -Unit # 2)	3 Nos (2W + 1S) Water cooled precision type package AC	3 X 20 TR (actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered.

ANNEXURE-D : SYSTEM CAPACITY & CONFIGURATION

Sl.No.	Location/Building	Equipment configuration	Capacity (Minimum)	Remarks
8	AC Plant-8 (ESP Control Building -Unit # 3)	3 Nos (2W + 1S) Water cooled precision type package AC	3 X 20 TR (actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered.
9	AC Plant-9 (ESP Control Building - Unit #4)	3 Nos (2W + 1S) Water cooled precision type package AC	3 X 20 TR (actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered.
10	AC Plant-10 (ESP Control Building -Unit # 5)	3 Nos (2W + 1S) Water cooled precision type package AC	3 X 20 TR (actual capacity)	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered.

ANNEXURE-D : SYSTEM CAPACITY & CONFIGURATION

Sl.No.	Location/Building	Equipment configuration	Capacity (Minimum)	Remarks
11	AC Plant-11 (FGD MCC & Control Room (Stage#1))	5 Nos (3W + 2S) Water cooled precision type package AC	5 X 15 TR (actual capacity) *	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) The final capacity of the of each water cooled precision AC's shall be decided and finalized based on the input architectural drawings provided with the technical specification during detail engineering.
12	AC Plant-12 (FGD MCC & Control Room (Stage#II))	5 Nos (3W + 2S) Water cooled precision type package AC	5 X 20 TR (actual capacity) *	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) The final capacity of the of each water cooled precision AC's shall be decided and finalized based on the input architectural drawings provided with the technical specification during detail engineering.
13	AC Plant-13 (DM Plant Control Room)	3 Nos (2W + 1S) Water cooled precision type package AC	3 X 15 TR (actual capacity) *	a) Sizes of other equipment's of the AC plant viz. cooling tower, condenser water pumps, water softening plant, Make up water tanks etc. shall be sized according to the Precision AC capacity, Heat load calculations & technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered. b) The final capacity of the of each water cooled precision AC's shall be decided and finalized based on the input architectural drawings provided with the technical specification during detail engineering.
14	Administrative Building	Air cooled type package AC for each floor (3 x 50 % in each PAC room). There are two rooms on each floor.	a) 12 X 20 TR (actual capacity) on second and third floor (6 nos of each floor) b) 6 x 15 TR (actual capacity on first floor) *.	The final capacity of the Air cooled package AC's per floor shall be decided by bidder based on the input architectural drawings provided with the technical specification. Minimum capacities specificed in technical specification and price format needs to be adhered.

ANNEXURE-D : SYSTEM CAPACITY & CONFIGURATION

Sl.No.	Location/Building	Equipment configuration	Capacity (Minimum)	Remarks
15	TG Hall Battery Charger Room at 8.5M	Cassette AC's (with 100 % standby)	Rating shall be decided during detail engineering	Air-cooled cassette type AC units consisting of condensing unit & evaporating unit including refrigerant pipes & fittings with insulation etc. Indoor unit of ceiling mounted casstte type unit (multi flow type) should have same decorative panel size regardless of their differece in capacity.

Notes	
1	The Air conditioning system equipment capacities and quantity provided above are minimum requirements. Although it will be endeavoured that there is no change in the capacities of main equipment yet in an unforeseen event of minor change in capacity of main equipment during detail engineering , the same shall be accommodated by bidder in already ordered prices.
2	The Air conditioning system equipment sizes for all areas other than those mentioned above shall be decided during detail engineering .

5X800 MW YADADRI TPS HEAT DISSIPATION FOR MAIN PLANT AREA					
Common Control Room	Unit-1 & 2	Unit-3,4 & 5	Unit-5		
	31 KW	38 KW	13 KW		
Control Equipment Room	Unit-1	Unit-2	Unit-3	Unit-4	Unit-5
	85 KW	85 KW	85 KW	85 KW	85 KW
Computer Room	Unit-1	Unit-2	Unit-3	Unit-4	Unit-5
	10 KW	10 KW	10 KW	10 KW	10 KW
UPS Room	Unit-1 & 2	Unit-3 & 4	Unit-5		
	90 KW	90 KW	30 KW		

SECTION: I

SUB-SECTION: C 2

CUSTOMER SPECIFICATION

Kothagudam Air conditioning to be followed for Yadadri project also. For configuration of various AC Plant, kindly refer Section I, Sub Section - C1

VOLUME : IIID

SECTION-I

TECHNICAL SPECIFICATION FOR AIR CONDITIONING SYSTEM

VOLUME: IIID

SECTION - I

AIR CONDITIONING SYSTEM

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SECTION – I

AIR CONDITIONING SYSTEM

1.00.00 INTRODUCTION

1.01.00 The purpose of the system is to provide Air Conditioning System for the different areas of 1X800 MW Supercritical Thermal Power Plant, Stage – VII Unit #12 at Kothagudem Thermal Power Station, Telangana.

Various control rooms in power station, housing a group of sophisticated and precision control panels and desks call for controlled environment for proper functioning and for the comfort of working personnel.

2.00.00 SYSTEM DESCRIPTION

2.01.00 The air conditioning system shall cover the following areas as a minimum:

a. Power House Building including Control Room

i. Unit Control Room
ii. Control Equipment Room (CER)
iii. Shift Charge Engineers' Rooms
iv. Computer Room
v. Uninterrupted Power Supply (UPS) Room
vi. Steam and Water Analyzer (SWAS) Panel Room (Dry Panel)
vii. Excitation room
viii. AVR room
ix. Relay panel room
x. Other Office areas like Telephone Exchange Room, Conference Hall, library, Laboratory Rooms etc, if any, on the operating floor

b. Service Building

i. Maintenance Office areas, conference rooms, lecture rooms and any other areas needs Air Conditioning.

ii. AC plant control room (in Central AC plant equipment room proposed to be located in ground floor of Service Building)

c. ESP Control Room.

d. VFD Control Room (if applicable)

e. Ash Handling Plant Control Room

f. DM plant control room, office and Laboratory area.

g. Switchyard Control Room.

h. Chemical Laboratory Building.

i. Coal Handling Plant control room

j. Any other Local Control Rooms / Cubicles of different Auxiliary Buildings housing Programmable Logic Controllers (PLC) Panels and other Input / Output (I/O) modules

k. Rooms having the equipment required controlled temperature by nature for their operating feature.

l. Any other area requiring Air conditioning as per manufacturer's recommendation.

All the buildings described above shall preferably be provided with separate air conditioning systems because they may be far apart from each other.

2.02.00 For the Power House Building and the attached Service Building, one Common Central Chilled type Air Conditioning plant shall be provided with individual Air Handling Units / Fan-Coil Units (as applicable) for the Unit Control Room, Control Equipment Room, Shift Charge Engineer's Room, Computer Room, Uninterrupted Power Supply (UPS) Room, Excitation Room, AVR Room, Relay Panel Room, SWAS (Dry Panel) Room, all Laboratory Rooms and other Office areas, Telephone Exchange Room, Conference Hall, and Library etc, if any, on the operating floor.

2.03.00 Water Cooled Precision air Conditioners of 3 x 50% capacity shall be provided for the ESP Control room, VFD Control Room (if applicable), AHP Control Room, DM Plant Control Room and its associated office and Laboratory and Chemical Laboratory Building. Condenser cooling water for these Air Conditioners shall be supplied from main plant ACW system through Non-Chemical Water Treatment Device. Provision of a Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.

2.04.00 Air Cooled Packaged Units (Precision Type) will be used for air conditioning of the Switch Yard Control room and CHP Control room. Provision of a Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.

2.05.00 Air cooled non duct able Split Air Conditioners shall be provided for Rooms / cubicles housing Programmable Logic Controllers (PLC) and other Input / Output (I/O) modules or any other area requiring for Air conditioning. Required no. of AC units of suitable capacity should be selected with 100% units as stand-by for AC areas having 24 hours operation. For AC areas with less than 12 hours operation, stand-by units may be avoided if multiple units are installed.

2.06.00 The systems described above are only minimum requirement. Any other area/areas, if felt by the Bidder himself or by the Purchaser/their consultant, or if demanded by the process/equipment should be air conditioned, shall be included in Bidder's scope of work.

2.07.00 The foregoing and subsequent clauses specify the equipment/system for general guidance only. Any other equipment and /or materials necessary to ensure safe and satisfactory erection, commissioning and operation of the plant shall be supplied.

2.08.00 The air conditioning requirement for different areas are as follows:

2.08.01 One Common Central chilled water Air Conditioning system consisting of 2x100% Packaged Screw type Chiller Units associated with 2 x 100 % capacity Chilled water pumps, 2 x 100 % capacity Condenser water pumps , 2 x 100 % capacity Cooling towers and controls & instrumentation to serve the Unit Control room, Control Equipment room, Computer room, UPS room, SWAS (Dry Panel) room and Shift Charge Engineer's room, AVR Room, Excitation Room, Relay Panel Room, Other Office areas, telephone exchange room, Conference Hall, library and Laboratory etc, if any, located in the Power House building and all the floors of the attached Service Building.

Clarified water shall be used as the make-up to cooling towers. This condenser cooling water will be treated through the Non-Chemical Water Softening Equipment installed in the common header of Condenser water pump outlets.

2.08.02 Unit Control Room & Shift Charge Engineer's Room, Computer Room, Control Equipment Room and UPS room in the Control Building will be served by at least 2 nos. each of 50% capacity AHUs located in the AHU Room.

For SWAS (Dry Panel) Room and Shift Charge Engineer's Room, AVR Room, Excitation Room, Relay Panel Room, Other Office areas, Telephone Exchange Room, Conference Hall, Library and Laboratory etc, if any, and the attached Service Building individual AHUs/ Fan Coil Units shall be provided. Each floor of Service Building shall have separate AHUs. For each room / area at least 2 nos. AHU/FCU shall be provided.

However, the combination of areas to be served by AHUs / FCUs will depend upon the actual layout when the building drawings will be finalized.

2.08.03 1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each AHU Room serving critical areas like Control Room, Control Equipment Room, UPS room, AVR Room, Excitation Room, Relay Panel Room, Telephone Exchange Room, Laboratory, etc.

For other non-critical areas like Office areas, Conference Hall, Library, various floors of Service Building fresh air will be inducted in the AHU room through the wall mounted rain protection cowl with bird screen and a volume control damper.

1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room serving critical areas like ESP Control Room, VFD Control Room (if applicable), Ash Handling Plant Control Room, Chemical Laboratory Building, DM Plant Control Room, Office and Laboratory area, Switchyard Control Room and Coal Handling Plant Control Room etc.

Fresh air for small areas like SWAS room, AC plant control room, small office and control rooms fresh air will be inducted through door opening.

2.08.04 1 x 100 % capacity Electrode Type Humidifier with associated controls and accessories shall be provided in each AHU room serving critical areas of Power House Building.

2.08.05 Provision of Duct mounted Electric Strip heater and High Efficiency Filter shall also be kept with the common supply duct from the AHUs serving critical areas like Unit Control Room, Shift Charge Engineer's Room, Computer Room, Control Equipment Room, UPS Room. AVR Room, Excitation Room, Relay Panel Room, telephone exchange room, Laboratory, etc.

Duct mounted Electric Strip heater shall be provided with the common supply duct for non-critical areas like Office, Conference Hall, library, various floors of Service Building etc.

2.08.06 Smoke Evacuation system consisting of smoke exhaust fans with ducting, motorized isolating dampers and rain protection cowl with bird screen shall be located in AHU rooms serving control room and associated areas of Power House building.

2.08.07 Exhaust fans of required capacity & quantity to be provided for Central AC plant equipment room.

3.00.00 SCOPE OF WORK

Scope has been defined under subsequent Clauses.

3.01.00 Central Chilled Water Air Conditioning Plant

The central chilled water AC plant consists of the following equipment:

3.01.01 Two (2) Nos. (one as running and one as stand-by) Water Cooled Screw Chiller Unit of adequate capacity and each consisting of:

a) One(1) / Two(2) Nos. Screw Compressors (As per Manufacturer's standard).

Type: Rotary Screw type, hermetic/semi- hermetic, directly driven, R-134a duty.

Accessories include suction and discharge shut-off valves, discharge check valve, oil Separator, oil heater, HP, LP, Low oil level cutout, high winding temperature cutout through PTC sensors, Motor overload cutout, liquid Injection system, integrated pressure relief valve, oil service valve, Step less Automatic capacity control arrangement with automatic unloaded starting device, Anti Recycle device, Heater, Setting and Overhauling tools, foundation bolts, vibration isolating device etc.

Adequately sized Induction Motor (for the above compressors) suitable for 415V ± 10%, 3 phase, 50Hz ± 5% AC. AC Supply.

b) One(1) No. Refrigerant Condenser.

Type :Water cooled, horizontal, shell and tube R-134a duty & capacity to match the above compressor with integrally finned copper tubes with steel shell having adequate surface area to cater to the requirement of the above compressor & to provide sub-cooling by 2 Deg. C at least.

Design fouling factor : Not less than .0002 Hr. Sq. M. ^{0}C/Kcal (.001 Hr-Sq. ft ^{0}F/BTU).

Heat removal and water flow rate :To be calculated and furnished by be Bidder.

Accessories: Relief valve, vent connection with valve, De-scaling connection, charging connection, water flow switch, drain connection with valve. Thermo-well connections on water side, liquid trap etc.

c) One(1) No. Refrigerant Chiller.

Type : Horizontal shell and tube direct expansion/flooded type R-134a/water duty with copper tube having adequate surface area to provide superheating by 3 Deg.C.

Design fouling factor : Not less than 0.00013 hr-Sq. m. C/Kcal (0.00065 hr-Sq. ft. Deg. F./ BTU).

Heat removal and Water flow rate: To be calculated and furnished by the Bidder.

Accessories: Liquid and water connection provided with thermo-wells, water flow switch and pressure gauge connections.

At least 39 mm thick insulation of Aluminium foil faced Nitrile Rubber /XLPE or equal, with removable type insulated flange cover, water side drain connection with valve in every portion of the chiller isolated by baffle plates.

d) Piping & Auxiliaries : Common base frame for compressor, condenser, chiller unit fabricated of M.S. angles, channels etc. anchor bolts, nuts, hot gas piping, cold gas piping, liquid refrigerant piping all of seamless steel or ERW steel pipes, insulation of cold gas piping with minimum 39 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal liquid valves, muffler if needed, gauges and instrument piping, filters, drier, moisture indicator isolating valves etc. as may be required for safe and trouble free operation. The entire chiller package assembly shall be installed with spring type vibration isolation devices (One set for each chiller unit)

Equipment drain water connection with siphon and valves, fittings etc. up to the nearest drain point with proper insulation shall also be included.

e) Controls: Electronic expansion valve, solenoid valve in the refrigerant circuit, operating temperature sensor and anti freeze thermostat/ sensor.

Microprocessor based control panel of each chiller unit will provide safety against high & low refrigerant pressure, low oil pressure, freezing of chilled water, overload, winding heating and single phasing and phase reversal of compressor by means of high & low pressure transmitter, oil pressure transmitter, temperature sensors & transmitter, O/L relays, Thermistor relays, etc. and other safety Controls including Over/Under voltage and voltage unbalance protection, over/under current and current unbalance protection and others as per manufacturer's standard.

It will also provide capacity control by sensing low chilled water return temperature through operating temperature sensor and motorized sliding valve. Other safety devices like flow switches for the condensers and chillers, compressor unloaded starting device shall also be provided through Microprocessor based control panel. (One set for each chiller). Such Microprocessor based Control Panel shall be provided with 20% extra properly wired I/O units.

f) Oil and Refrigerant: First charge of refrigerant R-134a and oil for the above chiller units.

3.01.02 Condenser cooling water piping of MS ERW (heavy grade) complete with valves, fittings, hangers / supports. between cooling towers and condensers (of Screw Chiller Units) including the condenser cooling water pumps complete with valves, bends, strainers, fittings, instruments, hangers and supports etc. Equipment drain water connection and valves, fittings etc. up to the nearest drain point shall also be included. A single line diagram in this connection is to be furnished by the Bidder.

3.01.03 Chilled water piping connecting the chillers(of Screw Chiller Units), chilled water pumps and cooling coils of air handling units / FCUs and expansion tank, complete with valves, bends, strainers, fittings, instruments, hangers and supports, insulation etc. A single line diagram in this connection is to be furnished by the Bidder.

The insulation shall be at least 39mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal (Refer elsewhere for detailed specification of insulation). For Chilled water drain pipes the insulation thickness shall be at least 26 mm.

3.01.04 Make up water piping of medium class GI complete with fittings, hangers / supports from Make-up Water tank through booster pumps (1R+1S) to various points of consumption like cooling tower sumps, expansion tank and Humidifiers.

3.01.05 Two (2) Nos. (1 working + 1 Stand-by) Condenser Cooling Water Pumps to meet the requirement of the Central Chilled Water plant.

Type : Centrifugal, horizontally split casing / end suction type, single stage directly coupled to electric motor and mounted on a common base frame.

Speed : Preferably not more than 1500 rpm.

Capacity and Head : To be calculated and furnished by the Bidder.

Duty : Continuously running.

Accessories : Pressure gauges at suction and discharge, isolating valves, all integral piping, required for sealing, cooling etc. strainers, check valves, flexible coupling guard, foundation bolts and nuts etc. and other standard accessories as may be necessary for successful operation. Vibration isolators shall also be supplied. Condenser water pumps shall be provided with mechanical seals.

Motor for the above : Adequately sized TEFC, squirrel cage induction motor, suitable for 415 V ±_10%, 3 pH, 50 Hz ± 5% supply.

3.01.06 Two (2) Nos. (1 working + 1 stand-by) Chilled Water Circulating Pumps for all areas.

Type : Centrifugal, horizontally split casing / end suction type, single stage directly coupled to electric motor and mounted on a common base frame.

Speed : Preferably not more than 1500 rpm.

Capacity and Head : To be calculated and furnished by the Bidder.

Accessories : Pressure gauges at suction and discharge, isolating valves, all integral piping required for sealing, cooling etc. strainers, check valves, flexible coupling guard, foundation bolts and nuts, complete insulation with minimum 39 mm thick Nitrile Rubber /XLPE or equal with 24G aluminium sheet cladding. For the pumps, vibration isolators shall also be supplied. Chilled water pumps shall be provided with mechanical seals.

Duty : Continuously running.

Adequately sized, TEFC squirrel cage induction motor suitable for 415 V ± 10%, 3 Phase, 50 Hz ±5% supply for the above.

3.01.07 Two (2) Nos. (1 working + 1 stand-by) Cooling Tower Induced draft cross/counter flow type to meet the requirement of the Central Chilled water plant. Design Wet bulb temp. will be 29 ^{0}C with a approach (Maximum) of 4.0 ^{0}C.

Construction of various components will be as under:

Casing	:	FRP
Louver	:	FRP
Fill	:	PVC
Drift eliminator	:	PVC
Strainer	:	Brass wire mesh
Headers and pipe connection	:	G.I.
Basin	:	R.C.C./FRP
Nuts and Bolts etc.	:	Suitable corrosion resistant material i.e. G.I. or cadmium plated.

Accessories include supports, supporting structure, make-up water piping with float valve, drain connection with siphon and valve, over flow and quick fill connections etc.

3.01.08 Expansion Tank

The expansion tank shall be made of G.I or FRP and shall be of adequate thickness & suitably reinforced. It shall be complete with make-up connection with float valve, quick fill connection, overflow connection and drain connection with valve. The tank shall be provided with level gauge glass and shall be completely insulated with 6 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal. The capacity shall be selected based on 1.2% of circulated chilled water capacity. Filtered water shall be supplied as make-up.

3.01.09 Make-up water Tank

The Make-up water tank shall be made of MS RL or FRP and shall be of adequate thickness & suitably reinforced. It shall be complete with make-up connection with float valve, quick fill connection, overflow connection and drain connection with valve. The tank shall be provided with level gauge glass. This tank will supply make-up water to Cooling towers, Expansion tank and

humidifiers.

3.01.10 Two (2) Nos. (1R+ 1S) Make-up Water Booster pumps.

Mono block type centrifugal pump to supply make-up water from the Make-up water tank to the Cooling towers, Expansion tank and humidifiers, each complete with drive motor, common base plate, isolating valves, non return valve etc.

3.01.11 One(1) No. on line Non-chemical water treatment equipment to suit the common condenser water header. The equipment shall be complete with flanges at ends and supports.

3.02.00 **Air Handling Units/Fan Coil Units with controls**

Number and individual capacities of Air Handling Units/Fan Coil Units should be calculated and furnished by the Bidder. Each A.H.U. shall consist of the following:

3.02.01 DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor suitable for AC 415V ± 10%, 3 Ph, 50 Hz ±5% supply shall be provided. M.S. Scroll casing of the fan will be suitably painted.

Accessories include V-belts with pulleys, belt guard, supporting frame, volume control damper etc.

NOTE: For small FCUs single phase motors shall be used.

3.02.02 1 No. Cooling Coil will be provided in each AHU. The cooling coil will be chilled water circulating type.

Construction will be seamless copper tubes with aluminium fins, number of fins as per manufacturer's standard but not greater than five (5) per Cm. [thirteen (13) per inch].

Design fouling factor will be 0.00013 hr-Sq. m.- ^{0}C/Kcal.

3.02.03 Panel type dry HDPE filter having an efficiency of 90% down to 10 micron size particles will be provided. A differential pressure sensor shall be provided across the filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

3.02.04 AHU will have Double skin G.I casing (Sand witched panel with internal insulation of min. 25mm thick TF quality Expanded polystyrene/ PUF) with inspection facilities, supports made in a 16-G M.S. structure of sectionalized construction with one coat of rust proof anti-corrosive paints followed by two coats of final paint and complete with insulated SS drain pan, insulated drain piping etc. The AHUs shall be cabinet type with Fan section, Coil section and filter section. Adequate space between Filter section and Coil section shall be

kept for maintenance purpose and proper air flow. Fan section also shall have adequate maintenance space all around the fan and motor.

3.02.05 One set of operating controls consisting of motorized modulating 3-way mixing valve with cooling coils of AHUs and FCUs with temperature sensor, transmitter and actuator for controlling the flow of chilled water, will be provided. Small FCUs shall have multi-speed motor.

3.03.00 **Fresh Air System**

Fresh air unit for Control room areas and areas served by Precision air conditioners shall consist of a tube axial flow/centrifugal fan with drive motor, inlet louver with bird screen, dry panel HDPE filters, volume control damper, supports, supporting structures etc. 1 x100% capacity Fresh air unit shall be provided in each AHU room / PAC room. A differential pressure sensor shall be provided across each set of filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

For Fan coil unit, there shall be provision for suitable arrangement of fresh air intake from the nearest evaporative cooling units.

For Service Building and other non-critical areas, fresh air opening with air inlet louver and a volume control damper shall be provided in the AHU room.

3.04.00 **High Efficiency Filter**

High efficiency filter having an efficiency of 99 % down to 5 microns mounted in supply air duct is to be provided for air conditioning of all control rooms and allied area. A differential pressure sensor shall be provided across the filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

3.05.00 **Electrode Type Humidifier**

Electrode humidifier consists of high temperature Polypropylene water tank, electrodes, auto flash cycle activated on demand from the microprocessor based control system with humidity sensor, located in the AHU room for control room areas of Power House building. This Humidifier shall also be complete with make up connection with float valve, overflow connection and drain connection with valve.

3.06.00 **Electric Strip Heaters**

Electric strip heaters will be of adequate capacity mounted in supply air duct with thermostat, humidistat, air stat/safety thermostat and controlling temperature sensor etc. (For winter heating purpose and for monsoon reheat purpose.) for control room areas of Power House building.

Electric strip heaters will be of adequate capacity mounted in supply air duct with thermostat, air stat/safety thermostat and controlling temperature sensor etc. (For winter heating purpose) for various floors of Service Building.

3.07.00 **Smoke Exhaust System**

Smoke Evacuation system consisting of smoke exhaust fan with ducting and motorized isolating dampers with cowl & bird screen shall be located in AHU rooms servicing Control room areas of Power House building. The fan and motor shall be designed to withstand a temperature of 400 Degree C for 2 hours.

3.08.00 **Duct Work**

Duct work includes:

a) G. I. Duct having zinc deposition of at least 180 gm/m².

b) Damper with control arrangement at each branch off and wherever necessary.

c) All supply & return air grilles and diffusers made of extruded aluminum powder coated and complete with volume control dampers (for SA grilles/diffusers only) and supporting frames.

d) Flexible connections of rubberized canvas.

e) Hangers and supports.

f) Sealing compound and jointing gasket for ducts.

g) 13 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal or equivalent thermal insulation for the entire air conditioning ducting.

h) Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner outlet.

i) Motorized fire damper with sensors, control etc. at strategic locations, as required. Provision of manual overriding operation through latch shall also be kept with the Motorized Fire Damper.

3.09.00 **Water Cooled Precision Air Conditioners**

Water Cooled Precision Air Conditioners shall be complete with scroll compressors (suitable for R-410/407c refrigerant) and water cooled shell and tube condensers, interconnecting refrigerant piping (duly insulated) between condensers and PAC units, evaporator fans with highly efficient EC motors and their controls, high efficiency filters, cooling coils with electronic expansion valve, electrode type humidifiers with controls, electric strip heaters, thermally and acoustically lined powder coated MS casing, insulated SS drain pan, insulated

drain piping, and built-in microprocessor based control panel.

Such Air Conditioners will be associated with air distribution system consisting of a GI duct - work as elaborated above, Non Chemical Water Treatment Equipment at the inlet to the condensers of PAC .Condenser cooling water will be fed to the condenser from the Plant ACW system.

3x 50% capacity Precision AC Units are to be provided each for each PAC room.

Provision of introducing fresh air into the PAC unit room shall be kept through Fresh Air Unit as described earlier.

3.10.00 **Air Cooled Precision Air Conditioners**

Air Cooled Precision Air Conditioners shall be complete with scroll compressors (suitable for R-407C / 410A refrigerant) and remote air cooled condensers, interconnecting refrigerant piping (duly insulated) between outdoor condensers and indoor PAC units, evaporator fans with highly efficient EC motors and their controls, high efficiency filters, cooling coils with electronic expansion valve, insulated SS drain pan electrode type humidifiers with controls, electric strip heaters and built-in microprocessor based control panel thermally and acoustically lined powder coated MS casing and insulated drain piping. Such Air Conditioners will be associated with air distribution system consisting of a GI duct - work as elaborated above.

3x 50% capacity Precision AC Units are to be provided each for each PAC room.

Provision of introducing fresh air into the PAC Unit Room shall be kept through Fresh air unit as described earlier.

3.11.00 **Air Cooled Non Duct-able Split Air Conditioners**
(Applicable for rooms/cubicles housing PLC and other I/O units, computer room and any other area requiring air conditioning)

Air Cooled Non Duct-able Split Air Conditioners shall be complete with hermetically sealed rotary compressors and air cooled condensers in the outdoor units with powder coated GI casing, built-in electrical items & supports and Indoor units housing dry panel type HDPE filters, cooling coils, evaporator fans with two speed drive motors, all encased in powder coated GI casings with swiveling type supply air grilles and decorative RA grilles and interconnecting refrigerant piping (duly insulated) between outdoor and indoor units and insulated drain piping, microprocessor based cordless remote control panel and 240V, single phase MCB with connecting cable for each split unit.

Required no. of suitable capacity should be selected with 100% units as stand-by for all rooms/ cubicles housing PLC and other I/O units/ computer room running for 24 hours.

For AC areas with less than 12 hours operation, stand-by units may be avoided if multiple units are installed.

3.12.00 **Electrical Work**

3.12.01 **One (1) 415 V Motor Control Centre (MCC)** for operation and control of the complete Central AC system required for the Power House Building and the associated Service Building. The MCC be shall be located in the central Air-Conditioning Plant room.

Each MCC shall be fed by 2 x 100% incoming feeders, which shall be located at either end of the panel.

3.12.02 **One (1) no. Local Starter Panel (LSP)** for each AHU room of Power House Building and attached Service Building. This LSP will house In-coming MCB, outgoing starter for all drives located in AHU room and MCB for heaters, humidifiers and FCUs.

3.12.03 **One (1) 415V Power Distribution Board (PDB**) each for supplying power to the PAC units of each Auxiliary Building.

Each PDB shall be fed by 2 x 100% incoming feeders, which shall be located at either end of the panel.

3.12.04 Non Duct-able Split units shall be fed from local distribution board / nearest power source available in the respective building.

3.12.05 All the Electrical items as described above shall be as per relevant volume of the technical specification on electrical work.

3.12.06 DDC Based Control Panel

I. Control, monitoring, operating and safety controls & interlocks, indication and audio-visual annunciation for all AC equipment of the Central Chilled Water Plant and AHU rooms shall be activated from central DDC based Control Panel located in the AC plant control room.

II. Power shall be fed to this DDC Panel from the MCC located in the Central AC plant room. This DDC panel shall be interfaced with the MCC, Individual Microprocessor based Control panels of Chillers and LSPs located in AHU rooms.

III. This DDC panel shall be associated with two nos. Workstations (Engineering & Operating).

IV. The DDC System shall consist of:

a) One (1) no. DDC panel housing Direct Digital Controllers for Central Air Conditioning System. The DDC panel shall be suitable for HMI interfacing directly with sensors, actuators and environmental delivery systems (i.e., all component equipment and accessories of AC system), controls and monitoring for the central AC System. This Control system along with one work station shall be complete with necessary software & Licenses (OS cum ES) for control

and monitoring of the Central AC System and generation of alarm list, report etc.

b) One (1) no work station complete with suitable Central Processing Unit (CPU) Key Board, Mouse and Video Display Unit (VDU) with 21 inches monitor.

c) Necessary battery back up for RAM for 24 hours continuous operation during power failure and necessary UPS and battery charger with minimum 30 minutes back up.

d) Necessary UPS Battery & Charger for DDC System back up shall be provided in the AC Plant Control Room.

e) Necessary interface hardware and software for interconnection with other system for two-way data transfer for information exchange. The data format, the exact number of points etc. shall be finalized during detailed engineering stage.

f) All other necessary hard wares to make the system complete and functional.

g) One Common Hooter for audio annunciation of any malfunction of AC equipment and systems.

h) System earthing and panel earthing of the DDC Panel.

i) The DDC shall have inbuilt PID function's for precise control of the process parameters.

j) The user friendly programming shall be done via Windows software.

k) Interlock list for equipment should be incorporated in the operator station.

l) Alarm List (Process & System), Event List , Different level of security.

m) The DDC Control system and its HMI shall have necessary Graphic user interface for display of the processes with indication of devices and instruments. In case of alarms the alarm indication window will be displayed on the screen to attract the attention of the operator and generate output for audio-visual annunciation.

n) Various controls and annunciations to be provided in DDC panel shall be as per clause no. 4.00.00: Control Philosophy.

3.12.07 Local Push Button Stations

Local Push Button Stations shall be provided for each drive motor and equipment (Cooling Tower Fan Motors, FCUs and Make-up Water Booster Pump Motors etc.), suitably located near drives and equipment of each AC system. LPBS shall consist of one no. emergency Red Stop P.B (pressed to latch and turn to release type) for each drive.

Local Push Button Stations shall be as per the relevant Volume of the electrical specification.

For Other detail VOLUME : II-F shall be referred to.

3.12.08 Local Distribution Board (240V)

Local Distribution Boards containing Switch / MCB for Non Duct-able Split Air Conditioners detail specification VOLUME : II-F shall be referred to.

3.12.09 Drive Motors

i) Motors shall be supplied with mounting and coupling hard wares such as base plate, coupling, coupling guard, anchor bolts and nuts, all hardware etc.

ii) Design ambient temperature of all motors for air conditioning system shall be 50℃.

iii) Motors shall have class F insulation but the temperature rise shall be limited to that of class B over an ambient temperature of 50℃.

iv) The motor nameplate kilowatt rating multiplied by the motor nameplate service factor shall be at least 15% greater than the driven equipment operating range maximum brake kilowatt.

v) Motors rated 30 KW and above shall be provided with space heater suitable for 240 V, 50 Hz, 1 Ph. AC.

vi) Motors rated below 250 watts shall be suitable for 240 V, 50 Hz, 1 Ph. AC. Motors rated 250 watts and up to 160 KW shall be suitable for 415V±10%, 3-Phase, 50Hz±5% AC.

vii) Motors rated above 110 KW shall be fed by Air Circuit Breaker and others of lower rating shall be fed by MCB/MCCB.

viii) All motor enclosures shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather proof construction.

ix) All drive motors shall be as per relevant Volume of the Electrical Specification.

3.12.10 All Power, Control and Instrumentation cabling as required and conforming to the requirement of relevant Volume of Electrical Specification.

3.12.11 Grounding of all electrical items as per relevant Volume of Electrical Specification.

3.13.00 Suspended Ceiling work with supporting grids, hangers etc. for all the air conditioned areas. The Suspended Ceiling shall be complete with 12mm thick GYPSUM board at various elevations including supplying, fixing snap grid

systems of approved manufacturer with 40 mm X 50 mm cross tees and 40 mm X 50 mm end channels including MS hangers, cleats, supports, turn-

buckles, ties placed around 1200 mm (Max.) centre to centre for forming frame work to support snap grid systems and lighting fixtures including all ancillary work at site like providing of various cut outs, holes, recess, trap door (removable panels), wherever shown, welding to reinforcement to hangers, if required, grouting of hangers and complete with all finish in super decorating manner, providing openings for lighting and air conditioning fixtures including painting of all structural with two coats of approved primer and final paint and also complete with all materials as per working drawings, and direction of engineers.

3.14.00 Under-deck Insulation work for all the air conditioned areas.Roofs of AC spaces are insulated with 25 mm thick EPS (Under-deck) for roofs not exposed to Sun and 50mm thick EPS (Under-deck) for roofs exposed to Sun.

3.15.00 **Supply, Erection, Testing and Commissioning**

3.15.01 Erection, testing and commissioning of all the equipment and accessories mentioned herein above including supply of all grouting pieces, all matching flanges, connecting flanges, valves and other fittings bolts, nuts, gaskets and supporting arrangement as required, are included in the scope of work.

3.15.02 Base plate and foundation plates including anchor bolts, nuts, loose fittings etc. for equipment and as would be necessary for erection and complete anchoring of steel materials for the pipes, hangers and supports for water chilling unit and other equipment, are to be supplied.

3.15.03 At least 39 mm thick Aluminium foil faced Nitrile rubber / XLPE insulation on refrigerant piping as required for the Precision type PAC units and 26 mm thick similar insulation for Non Duct-able Split units.

3.15.04 Supply, erection, testing and commissioning of all electrical drives and equipment mentioned herein above including supply erection, testing and commissioning of cables, cable trays, grounding of all drives and equipment for each AC plant and system as required for efficient and trouble-free operation and successful commercial operation, are included in the scope of work.

Erection, testing and commissioning of electrical drive motors and equipment shall be as per relevant volume of the specification.

3.16.00 **Consumables**

All consumables such as grease and lubricating oil for one year's trouble free operation after handing over, are to be included.

3.17.00 **Spare parts**

Supply of recommended spare parts for three years trouble free operation and maintenance is to be included.

3.18.00 **Special tools and tackles**

Supply of special tools and tackles including tool box required for operation, maintenance and overhauling of the system is to be done.

3.19.00 **Documents**

Drawing, data, characteristic curves and instruction manuals for the equipment and system as detailed herein after and as described in the relevant volume of the specification are required.

3.20.00 **Training of Purchaser's Personnel**

Contractor is to arrange for training of purchaser's personnel for operation and maintenance of the plant and equipment supplied.

3.21.00 **General**

Above clauses specify the equipment for general guidance only. Any other equipment and/or materials necessary to ensure safe and satisfactory erection, commissioning and operation of the plant shall be supplied.

4.00.00 **CONTROL PHILOSOPHY**

4.01.00 **Chilled Water Air Conditioning System**

The chilled water plant shall operate with 2 x 100% capacity Packaged Screw Chiller unit (1R+1S), 2x100% capacity (One no. working and one no. Standby), condenser water (CW) pumps, 1x100% capacity (One no. working and one no. Standby), chilled water (CHW) pumps, 2x100% capacity (One no. working and one no. Standby) induced draft-cooling towers.

All the equipment of this system shall be operated from the PLC system work stations located in the AC plant room. Furthermore cooling tower fans, make up Water Booster Pumps and FCUs shall also be operated from their individual local Push-button stations.

One no. Local starter Panel shall be installed in each AHU room which will feed power to all the AHU fans, motors of 3-way mixing valves of AHUs, Fresh air fans (wherever applicable), Smoke Exhaust fans (wherever applicable) and their motorized isolating dampers, Fire damper motors, Electric heaters and Humidifiers and FCUs of SWAS rooms, UPS Room. This equipment located in each AHU room and SWAS/ UPS Room shall be operated and controlled from the workstations through PLC system located in the AC Plant Room as well as from these Local Starter Panels.

FCU/s for AC Plant Control room shall be operated from the workstations through PLC system and from their local Push-Button stations.

The Packaged Screw Chilling units shall incorporate microprocessor based control panel, which will also be interfaced with the PLC system.

The Packaged Screw Chilling units can be started only when its associated cooling tower fans, condenser & chilled water pumps are in operation.

All the drives of the AC system shall be manually started / restarted through PLC from the work stations after any trip.

The chilled water system shall be provided with the following safety & operating controls:

(i) Operating Control:

Room temperature control with the help of modulating 3-way chilled water flow regulating valve with the cooling coil of AHUs / FCUs through the central PLC system, getting sense from the temperature sensor and associated transmitter placed in the return air path.

Chilled water temperature control based on the room load with the help of operating temperature sensor and controlling through compressor's automatic unloading mechanism for screw chillers through the built-in Microprocessor based control panel of Packaged Screw Chiller. This control shall also be possible through the central PLC system.

Room RH control with the help of humidifiers (if required) & duct mounted re-heaters through the central PLC system getting sense from the RH & Temperature sensors and their associated transmitters placed in the return air path inside AHU rooms.

(ii) Safety Control:

The chilled water system shall be incorporated with the following safety controls and interlocks:

High discharge pressure cutout (HP).

Low suction pressure cutout (LP).

Low oil level cutout

High winding temperature cutout
through PTC sensors

Low chilled water temperature cutout by anti-freeze thermostat /temperature sensor for Screw chiller.

Cutout due to low flow of chilled water & condenser water by flow switches.

Cutout due to overload of all drive motors.

High air temperature cutout by safety thermostat / temperature sensor for duct mounted electric heaters.

Low cooling tower sump water level cutout for CW pumps. (Alarm for low water level in expansion tank & humidifier as applicable shall be provided).

Stopping of AHU fans in case of fire in the respective zone through the central PLC system.

Short circuit protection.

Closing of fire dampers at the air supply duct from AHUs in case of fire with the sense from room mounted fire/smoke detector through zonal fire panel and the PLC system.

Heater for compressors, which will be energized during compressor idling time. This safety control shall be actuated through the built-in Microprocessor based control panel of each Screw chiller.

Safety controls of Screw chillers will also include Over/Under voltage and voltage unbalance protection, Single phase & Phase reversal preventor, over/under current and current unbalance protection and others as per manufacturer's standard.

(iii) Interlocks:

The system components shall be interlocked with one another in the following way:

The Screw Compressor shall not start unless:

At least one cooling tower fan is running.

At least one condenser water pump is running.

At least one chilled water pump is running.

The duct mounted electric strip heater shall not be energized unless the respective AHU fans are running.

All the above Interlocking shall be actuated through the PLC Panel.

On-Off-trip status for all the drives, electric heaters & humidifiers (if required) shall be available at the work stations of the PLC Panel located in the respective AC plant rooms.

Motors of fire dampers provided in supply air duct of AHU shall remain energized in normal condition to effect opening of dampers. In the event of fire, the motors of fire dampers will be de-energized and the damper will close due to spring action, the relevant AHU fan motors will be tripped at the same time. These dampers shall be operated through the PLC Panel getting signal from relevant duct mounted smoke detectors / fire alarm panel.

Provision for one common audio annunciation for any kind of malfunctioning in AC plant shall be kept through a hooter located in the AC Plant Control Room and suitably interfaced with the PLC Panel.

The control system shall comprise central PLC Panels with two workstations located in the AC Plant control room.

The basic function of the system is as follows: -

To closely control and monitor inside temperature and humidity condition inside the air-conditioned spaces.

To optimize / minimize energy consumption by automated operation.

To provide centralized monitoring and control for various mechanical facilities including sequential start / stop of the whole AC system.

To generate maintenance data and alarms.

To maintain records of plant operation.

Programmed start / stop of individual AHU as per operating requirements and for maintaining the room temperature / RH by controlling the 3 way mixing valves at chilled water line, humidifier and duct heater.

Programmed start / stop of individual FCU as per operating requirements and for maintaining the room temperature by controlling the 3 way mixing valves at chilled water line.

Safe and reliable operation, supervision & control, alarm & event management and optimization, maintenance management of the entire AC system shall be accomplished with the PLC system.

The PLC system shall be interfaced with:

The Air Conditioning MCC.

The Microprocessor based control panels of Screw Chiller.

The LSPs located in each AHU rooms.

The Temperature and RH sensors and their associated transmitters located in the AHU rooms.

The Temperature sensors located in the rooms served by FCUs.

The zonal fire panels/ duct mounted smoke detectors.

The two work stations and the Hooter.

4.02.00 **Air Conditioning System with Water-Cooled Precision Air Conditioner**

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

(i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Superheat control by means of electronic expansion valve, wherever applicable.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

(ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.

- Low condenser water flow cutout.

(iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

a) Condenser water flow is low.

b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

4.03.00 **Air Conditioning System With Air-Cooled Precision Air Conditioner**

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

(i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Superheat control by means of electronic expansion valve, wherever applicable.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

(ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.

(iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

a) The condenser fans are running.
b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

4.04.00 **Non Duct Able Split Air Conditioners**

Non-duct able Split air-conditioners will be controlled from the unit mounted Control panel or from the cordless hand operated remote.

5.00.00 **DESIGN CRITERIA**

5.01.00 The design outside conditions are taken from Meteorological Station at Khammam nearest to Kothagudem Thermal Power Station area.
For designing of the equipment, outdoor conditions shall be considered as follows:

Outdoor design condition : Summer : 42.6 Deg. C (DB),
26.6 Deg. C (WB)

REFER SECTION - C1A

Monsoon : 30.9 Deg. C (DB),
25.8 Deg. C (WB)

Winter : 20.8 Deg. C (DB),

Inside design condition	:	22.0 Deg. C ± 1 Deg. C DB & RH 55 % ± 5% for critical areas like control room, control equipment rooms, computer room, UPS rooms, AVR rooms etc. 24.0 Deg. C ± 1 Deg. C DB & RH not exceeding 60% for the non-critical areas like offices, conference room, SWAS room, etc. and the areas served by split air conditioners. For service building the inside conditions shall be 24.0 Deg. C ± 1 Deg. C DB & RH not exceeding 60% in all seasons except winter. In winter a DB temperature of 22.0 Deg. C shall be maintained.

Any equipment/process demanding any other (less) temperature shall be provided with.

Floor area	:	As per actual layout
Roof area	:	As per actual layout
Glass area	:	As per actual layout. All windows in the Air Conditioned shall be provided with light coloured Venetian blind
Lighting load	:	21.4 Watt/sq.m (or actual) for all areas except shift charge engineer's room & service building where 16 watt per sq.m (or actual) shall be considered.
Occupancy	:	One (1) person in 12 sq.m (or actual)
Equipment/Panel load	:	As actual.
Solar load	:	Solar and transmission load through walls, roofs, doors, windows, glazing, floors etc. should be considered.
Ventilation Air	:	Fresh air at the rate of 1.5 air changes per hour for the control rooms and 1 air change per hour for office areas or at least 34 Cu. M/Hr. per person, whichever is higher, should be considered to achieve pressurization of air conditioned space and to meet the ventilation requirement of occupants.

Other loads	:	Heat load due to AHU fan motor, duct friction etc. shall be considered while finding total heat load.
Plant sizing	:	Plant sizing is to be done by allowing 10 % margin on total sensible and latent heat calculated on the basis of above design considerations. An overall margin of 10% on calculated cooling load shall be considered in selecting Plant capacity.

All Condenser cooling water pumps and chilled water pumps, AHUS and FCUS shall have further, 10% margin on their flow capacities.

Insulation	:	Roof over AC space exposed to sun will be provided with 50 mm thick expanded polystyrene or equivalent. Roof over AC spaces not exposed to sun will be provided with similar insulation of 25mm thickness.

5.02.00 Individual air handling equipment shall be provided for individual facilities. Chilled water flow control valve (3-way), strip heater and electrode humidifier are provided for maintaining inside conditions.

5.03.00 All water piping for the make-up at cooling tower sump, Electrode humidifiers, Expansion tank and Make-up water tank etc. shall be provided by the bidder. Such make-up water piping shall be taken from the nearest clarified water header.

5.04.00 Electric power supply will be 415V ± 10%, 3 phase, 50 Hz. ± 5% A C.

5.05.00 The basic proposal by the bidder shall be for equipment strictly according to the technical specification. The location of air conditioning equipment, layout of ducting, piping etc. shall be designed by the bidder and approved by the Consultants/Owner.

5.06.00 The bidder shall satisfy himself regarding the refrigerating capacity required for maintaining the end conditions inside AC spaces before submitting the offer. For this purpose, the basis of computing air-conditioning load mentioned earlier is to be referred. The bidder shall have to guarantee the end conditions mentioned earlier.

5.07.00 **Codes and Standards**

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below :

IS-659	:	Safety code for air-conditioning
IS-660	:	Safety code for mechanical refrigeration

ASHRAE-23	:	Standard method of testing and rating [67 Standards] air conditioner.
AR1-450-6	:	Standards for water cooled refrigerant Condenser.
ASME Sec. VII	:	Unfired pressure vessels
IS-4503	:	Shell and tube type heat exchanger.
ASHRAE 22-72	:	Method of testing for rating water cooled refrigerant condenser.
ANSI-8-31.5	:	Refrigeration piping.
ANSI-8-9.1	:	Safety code for mechanical refrigeration.
AR1-410	:	Standard for air cooling and air heating coils.
AR1-210	:	Standard for unitary air conditioning equipment.
IS-3588	:	Specification for electrical axial flow fans.
AMCA-210	:	Methods of performance test for fans.
BS-2831	:	Methods of test for air filters used in AC and general ventilation.
IS-4671	:	Expanded polystyrene for thermal insulation purpose.
IS-702	:	Industrial bitumen.
IS-1239	:	Heavy class Pipes for sizes upto 150 mm dia.
IS-8188	:	For Water conditioning.
IS-325	:	3 phase induction motors.
IS-4029	:	Guide line for testing 3 phase induction motor.
IS-210	:	Specification grey iron casting.
IS-2062	:	Structural steel
AMCA -Bulletin No. 210	:	Standard code of testing centrifugal and axial flow fans
IS-2825	:	Code of practice for welding mild steel
IS-2676	:	Dimensions for wrought aluminum and aluminum alloy sheets and strips.

ASHRAE Code	:	for various filter
IS-655	:	Specification for metal air ducts
BS-4735	:	Horizontal Burning for XLPE insulation
BS- 4370 Part-1	:	Dimensional Stability for XLPE Insulation
ASTM D 1056	:	Water Absorption for XLPE Insulation

Pump design and testing should correspond to the procedure mentioned in IS-1520.

5.08.00 The refrigerant for Split units shall be R-22 as per ARI designation.

5.09.00 For requirements of materials of construction, 5.00.00 of this section shall be referred to.

5.10.00 **Special Note**

In case any discrepancy is found between requirements of this section and those mentioned in other sections, stipulations of this section shall prevail.

6.00.00 DESIGN, CONSTRUCTIONAL AND OTHER REQUIREMENT

6.01.00 General Instruction to the Tenderer

6.01.01 The Tenderer shall refer only to those of the following clauses which are applicable for this particular project as detailed in clause 1.00.00 and 2.00.00 of this specification. The clauses which are not applicable for this project shall be ignored.

6.02.00 General Design, Constructional and other Requirement

6.02.01 All the equipment shall be capable of withstanding the stresses which may be experienced during normal operation and test.

6.02.02 All the equipment shall be designed to permit inter-changeability of parts and ease of access during inspection, maintenance, installation and repair of various parts.

6.02.03 All parts subject to substantial temperature changes shall be designed and supported such as to permit free expansion or contraction without resulting in leakages, harmful distortion, misalignment or play.

6.02.04 Proposals for repair or any similar operations involving the plugging, welding, boring or addition of metal to the original castings shall be submitted to the Purchaser/Consulting Engineer and approval shall be received before any such

work is carried out. Drawing showing details and locations of such modifications shall be submitted to the Purchaser/Consulting Engineer for his records.

6.02.05 All equipment shall be heavy duty type suitable for installation in heavy industries and for long period of uninterrupted service.

6.02.06 All materials used shall conform to the specification and shall be new and first class in all respects.

5.02.07 Anchor bolts, nuts and seating steel work shall be supplied with the equipment. Only hexagonal nuts shall be used for holding down the equipment, with proper lock nuts. All bolt holes shall be spot faced for nuts. In specific cases where not necessary, spot facing may be omitted.

6.02.08 Casting and welding shall conform to their respective specifications and shall be free from flaws and objectionable imperfections, machined true and in a workmanlike manner.

6.02.09 The separate pieces of equipment shall be marked with unit number The assembly drawings shall indicate part number of each equipment and unit number for easy correlation.

6.02.10 Coupling guards and belt guards shall be furnished as applicable.

6.02.11 All equipment, ducts, pipes, controls etc. shall be fully treated against corrosion and sealed against moisture, sand and dust ingress.

6.02.12 All plant including ducts and pipes as well as machines shall be vibration isolated, or otherwise treated so that :

- No excessive vibration is felt in the floors or walls of the rooms served by any machine.
- The mechanically induced vibration levels in floors, walls and ceilings of rooms are sufficiently small as to limit the radiation of the sound level to the rooms within acceptable levels.

6.03.00 **Packaged Screw Chillers**

A. Refrigerant Compressors (Twin Screw Type)

I. The compressor may be designed either for direct or for indirect drive.

II. The compressor assembly shall be adequately designed for minimum vibration and noise disturbances.

III. The shaft seal shall be of proven design.

IV. All safety devices against high-pressure refrigerant, low-pressure refrigerant and low oil pressure shall be provided, High winding temperature through PTC sensor. The compressor units must be provided with oil pressure regulator.

V. The horsepower of the compressor motor shall be sized for 115% of maximum rated power required for the unit including the drive loss.

VI. The compressors shall be provided with built-in-unloaded starting device. The compressor shall have automatic capacity control device preferably built-in-type to match reduced refrigeration load.

VII. Capacity control must be achieved by use of slide valve, which provides fully modulating capacity control from 100% to 10% (20%, at least) of full load. The slide valve shall be actuated by oil pressure controlled by external solenoid valves.

VIII. The oil separator should be effective enough to incur gravity drop out of oil from the refrigerant gas before it enters the condenser.

B. Heat Exchangers (Condensers and Chillers)

I. All condensers shall be of shell and tube type with water in the tubes and refrigerant in the shell.

II. All chillers for chilled water plant shall also be shell and tube type with water either in tubes or outside the tubes.

III. The heat exchanger shall be designed for a minimum working pressure of 10.5 kg/cm^2 gauge on the water side and 11.3 kg/cm^2 on the refrigerant side and shall generally conform to the latest ASME CODE for unfired pressure vessels Section- VIII. The design pressure shall have a reasonable margin over the maximum working pressure.

IV. The average velocity of water in tubes shall not be more than 2.5 m/sec.

V. Water heads or refrigerant heads of the heat exchangers shall be as not to allow leakage of fluid from one pass to the other.

VI. Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating.

VII. The overall fouling factor for the condensers and chillers shall be 0.0002 and 0.00013 Hr.M^2 ^{o}C /K Cal respectively.

VIII. The condensers shall be designed to provide at least 2 ℃ sub cooling of refrigerant under rated design condition. The water chillers also shall be designed to superheat the refrigerant by at least 3 ℃ under rated design condition.

IX. Testing and other design feature of the heat exchanger shall meet the requirements of TEMA Class-C heat exchangers or approved equal.

X. The heat exchangers shall have open able water boxes for ease in maintenance.

XI. The tube for water chillers shall be of deoxidised copper with or without integral fins. The tubes for the condensers shall also be copper with integral fins. The tube wall thickness at any point shall not be less than 18 SWG.

XII. The baffle plates and the tube sheets shall be made of steel. The shell shall be made up of seamless tube or shall be fabricated from flange quality steel plate (ASTM-A285 Grade-C). The tube support plates shall be made of flange quality carbon steel plates and shall be as per TEMA Standard.

XIII. The heat exchangers shall be provided with vent valve, relief valve, and/or safety fusible plug on refrigerant side and vent valve and drain valve on water side (at every section of the baffled shell of heat exchanger).

XIV. The tenderer shall quote packaged units having compressor, condenser and chiller assembly together in a single framework and mounted on a common base plate. Provision for refrigerant charging and chemical cleaning of water tubes shall be provided.

XV. Each heat exchanger shall be provided with water flow switch. This shall be interlocked with the control of the individual refrigeration system/corresponding compressor drive.

XVI. All the heat exchangers shall be provided, with standard connections like thermo wells, inspection valve and antifreeze thermostat / temperature sensor and external equaliser connection for expansion valves for chiller. Insulation shall be terminated in such a manner that it will not be damaged during removal of bolts, covers etc. Separate covers similar to flange covers shall be constructed to facilitate easy removal.

6.04.00 **Water Pumps**

6.04.01 Each pump shall be of horizontal split casing / end suction centrifugal type, directly coupled to electric drive motor and mounted on a common base plate. Pumps having motor of 5 HP capacity or below can be of mono-block construction, provided its materials of construction are as mentioned below and motor is as per desired motor specification.

The pump shall be complete with casing, impeller, renewable type wearing rings, shaft, shaft sleeve, bearings, stuffing box, Mechanical Seal (if applicable), cowlings, base plate etc. as applicable. The design pressure for the casing shall not be less than 16 bar for chilled water pumps.

6.04.02 Pump head-capacity characteristics shall be gradually rising from operating to shut off point without any zone of instability. The pump BHP-flow characteristics shall be preferably be non-over loading type beyond rated capacity point.

6.04.03 Operating speed of the pump shall not preferably be more than 1500 rpm. Vibration isolations of efficiency 90% (approx.) shall be provided.

6.04.04 Material of the pump shall preferably as follows (all material shall be of tested quality).

a)	Casing	:	Cast Iron, as per IS 210, Gr FG 260 for both CHW & CW pumps. (As per manufacturer's Standard)
b)	Impeller	:	Bronze to IS: 318 Grade 2
c)	Shaft	:	Carbon Steel C-45.
d)	Shaft sleeve	:	SS-410
e)	Wearing ring	:	Bronze
f)	Base Plate	:	Cast Iron

6.04.05 Pumps shall be provided with suitable bearings sized adequately to take the maximum possible unbalance load occurring due to all mechanical and hydraulic reasons.

6.04.06 Pump and drives shall be directly coupled through a flexible coupling. Suitable coupling guard shall be provided for each pump.

6.04.07 Each pump shall be completed with pressure gauge at the suction and discharge, isolating valves, all integral piping required for sealing and cooling, casing drain and vent connections etc. The pressure gauge of pump will be connected with a siphon and a two-position brass cock.

6.04.08 The rated BHP of the motor shall provide for 15% margin over the rated BHP of the pump. For other electrical particulars of the motor refer detailed specification of the motors.

6.04.09 The design of the pumps shall conform to the relevant IS Code.

6.04.10 Major rotating components of the pumps like impellers, balancing drums etc. shall be individually balanced statically and finally each pump shall be dynamically balanced.

6.04.11 The critical speed of the pump shall be at least 20% above the operating speed.

6.04.12 All pumps and motors shall be aligned properly, and bolted and doweled to a common base frame.

6.05.00 **Induced Draft Cooling Towers**

6.05.01 The cooling towers shall be cross flow induced draft type with FRP casing & sump with air entry on all four sides and air discharge on top. The fan motor shall be easily accessible from outside and out of moist air stream.

The internals shall be of stainless steel SS or MS epoxy painted to withstand corrosive atmosphere. The tower shall be of low height, suitable for round the clock operation at location in the space shown in the applicable drawings. The tenderer shall confirm that the tower supplied by them can be accommodated in the space shown in the drawing.

6.05.02 Cooling tower shall be of sufficient capacity to cool the rated amount of water through the specified range at the design W.B. temperature.

6.05.03 The structural frame work of the tower including all members and connections shall be designed for operating loads and prevailing wind pressure. Steel members shall be MS epoxy painted and be of sufficient size to safely withstand all imposed loads.

6.05.04 FRP casing sheets shall be clamped on close centre to the structural steel members. Rubber neoprene gaskets must be used on all bolted joints as a seal against water leakage.

6.05.05 Louvers shall be of fixed type.

6.05.06 The fan deck shall be of ample strength to support all loads normally encountered in operation and maintenance. Stiffeners shall be provided on the under side.

6.05.07 Galvanised steel ladder with safety cage and hand railing shall be provided in such a number and locations as necessary to give safe and complete access to all parts to tower requiring occasional inspection or adjustment. An access door shall be provided for fan deck and the cell for ready access to the interior parts of the tower.

6.05.08 Fills shall be of extended area of formed PVC suitable to withstand hot water temperature of 55℃.

6.05.09 Louvers and drift eliminators shall be of PVC/FRP construction.

6.05.10 Eliminators shall be provided in removable sections & installed in the cell of the tower. The number of deflection in the eliminators shall be so arranged as to reduce drift loss to 0.2% of the water circulated.

6.05.11 The water distribution system shall be open basin with gravity feed nozzles. The system shall be self draining and non-clogging and designed for flexible operation and ready accessibility. All main piping connection shall be brought out and end in flanges, to flexible connection.

6.05.12 The cold water basin shall be of F.R.P. construction. The basin shall be complete with float valve for male up water control, a drain and overflow connection. The make-up water supply pipe shall be positioned at least double the pipe diameter above the maximum water level in the basin. The water basin shall be constructed such as to provide a coarse strainer of Brass wire mesh easily accessible from outside.

6.05.13 Fan shall be of the propeller type, cast aluminium and multi bladed aerofoil construction with adjustable pitch. The entire fan assembly shall be statically balanced. Outlet velocity of air shall be not less than 610 meters per minutes and the fan tip speed shall not exceed 4570 meters per minute.

6.05.14 Each fan shall be gear driven. Where reduction gears are used, housing shall be of heavy cast iron construction with large oil reservoir and complete with supply of oil.

6.05.15 Fan motors shall be of the totally enclosed fan cooled type and of the required capacities. Motor shall preferably be located outside the moist air stream.

6.05.16 Fan drive shaft using reduction gearing shall be dynamically balanced and connected through flexible couplings.

6.05.17 The mechanical equipment assembly shall be adequately supported on the fan deck.

6.05.18 Fan discharge hatch shall be covered with galvanised wire mesh to prevent birds nesting during idle periods.

6.05.19 All nuts, bolts and fasteners used in the cooling tower shall be stainless steel / Nickel or chrome plated.

6.06.00 **Piping**

A. Refrigerant Piping

I. Refrigerant piping shall be of M.S. seamless (as per IS-1239, Part-I heavy grade) or copper tube (IS-5493). Welding rings shall be used for smaller pipes. Weld preparation of joints, cleaning of pipes shall be carried out as per relevant code.

II. Pressure drop in hot gas, liquid and suction lines should not exceed the value corresponding to 2 ℉ (1.1 Deg C) change in saturation temperature of the fluid.

III. Velocity in the discharge and suction pipe of the refrigerant shall not be too high as to create undue vibration and noise, velocity in the vertical length of discharge and suction pipe of the refrigerant shall be high enough to carry the entrained oil in the refrigerant, even in case of unit running at lowest partial capacity. An angle type drain valve with male flare outlet connection will be installed at the bottom end of each vertical riser pipe to drain any accumulated oil.

IV. Instrument piping for gauges, switches etc. shall be copper only. Capillary tubes will be used wherever possible. For field-mounted instruments, this is not applicable.

V. Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Bidder.

VI. Liquid-moisture indicator with leak proof glass on opposite sides shall be provided in the liquid line for facilitating visual inspection of liquid refrigerant charge.

VII. The liquid line shall be provided with Drier-Strainer.

B. Water Piping

I. Condenser cooling water piping and chilled water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I, for higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade. Drain water piping shall be of M.S. heavy grade.

II. The piping shall be so designed that the water velocity through the piping shall not exceed 2.5 m/sec and also the piping friction drop shall be limited to 4 m per hundred meters of pipe length. Pipe sizes indicated in tender drawings shall be followed.

III. The pipes shall be of plain end in case of M.S. Pipes (i.e., suitable for welded connections) as far as possible.

IV. Counter-flanges for connecting to flanges on valves or equipment shall be made of IS-2062 or superior and shall preferably be slip on type, suitable for welding on the piping in case of M.S. Piping.

V. All bolts and nuts for flange connection shall be hexagonal carbon steel type as per IS-1363 and with the material and other requirements as per IS-1367. All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flanged connections for ease of removal / replacement of valves.

VI. Bends, fittings fabricated at site are not acceptable. The Contractor shall use the standard fittings / bends, as per IS-1239, Part-II.

VII. Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the

Bidder. The supports within the plant room shall be of structural/pipe supports from the floor, provided by the A.C. Contractor.

VIII. The flanged joints for water line will use canvas, impregnated rubber gasket. Compressed fiber gaskets shall be used with flat face flanges and raised face slip-on flanges. Spiral wound gaskets shall be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

Gaskets shall be suitable for the design pressures and temperatures: -

i) Compressed Fiber Gaskets: Compressed fiber gaskets shall be in accordance with ANSI B16.21, and materials shall be suitable for a maximum working pressure of 40 bar and a maximum working temperature of 400° C. Gaskets shall be dimensioned to suit the contact facing. They shall be full faced for flat face flanges and shall extend to the inside edge of the boltholes on raised face flanges. Gaskets for plain finished surfaces shall be not less than 1.6 mm thick and for serrated surfaces shall be not less than 2.4 mm thick.

ii) Spiral Wound Gaskets: Spiral wound gaskets shall be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. The gasket shall be inserted into a steel gauge ring whose outside diameter shall fit inside the flange bolts properly positioning the gasket. The gauge ring shall serve to limit the compression of the gasket to the proper value. Compressed gasket thickness shall be 3.3 mm ±0.1 mm.

iii) Ring Joint Gaskets: Ring joint gaskets shall be octagonal in cross section and shall have dimensions conforming to ANSI B16.20. Material shall be suitable for the service conditions encountered and shall be softer than the flange material.

iv) Rubber Gaskets: Rubber gasket materials shall be cloth inserted sheet rubber and shall conform to ANSI B16.21. They shall be full face and 1.6mm thick.

The material should be able to withstand adequate strength in compression without damage. Pipe lines should be such installed that any equipment or valves can be removed by disconnecting flange bolts and nuts union joints. If necessary, a short piece joint to be installed for easy removal. All threads for screwed joints should be properly made. The threads will be covered to make a leak proof joint. Pipes passing through any building structure will pass through a pipe sleeve. The thickness of pipe sleeve will be not less than the

thickness of the passing pipe itself. A rubber grommet or such other material will protect pipes entering any equipment.

IX. All drainpipes will use 'tee' fitting instead of elbows or bends. 'Tee' fitting should be such installed that the plug can be removed and any section of pipe can be cleaned. Drain valves will be located at lowest point of pipelines. If necessary more than one drain valve will be

installed to facilitate complete drainage from pipe. Condensate drain piping shall be insulated as per the specification.

X. Water filling valve and air vent shall be installed on the highest point of pipeline. If necessary more than one valve is to be installed for satisfactory operation or maintenance of the plant. In case of insulated pipes the connections for pressure gauge, thermometer, drain valve, purge valve, filling valve and any such other accessories, the connection should be long enough such that the requisite pipe insulation can be carried out on the main pipe. The connecting pipes or fittings will be insulated separately if necessary. Location of instruments, fittings, fixtures shall be as in single line flow diagram. Location / sizes of air vents are also indicated.

XI. The insulation will be fixed as per manufacturer's recommendation. Where valves, pipe fittings etc. occur, access to both shall be provided. Flange insulation shall be in two halves for easy removal without affecting insulation covering adjacent parts. Insulation of valves shall be with provision of aluminium valve boxes with hinged cover / halves.

XII. Piping arrangement and alignment shall be as per layout.

6.07.00 **Valves & Accessories**

A. General

Valve pressure classes, sizes, types, body materials, and end preparations shall generally be as described herein. Special features and special application valves shall be utilized where required.

Valves specified to have flanged, socket-welded, or screwed connections shall have ends prepared in accordance with the applicable ANSI standards. Steel flanges shall be raised face type unless otherwise required. Cast iron and bronze flanges shall be flat-faced type. Butt-welding ends shall be prepared in accordance with 2.11.5 Butt Weld End Preparation and Piping Fit-Up.

Steel body gate, globe, angle, and check valves shall be designed and constructed in accordance with ANSI B16.34 as applicable. Valve bodies and bonnets shall be designed to support the valve operators (hand wheel, gear, or motor) with the valve in any position, without external support.

B. Steel Body Valves 50 mm and Smaller

Steel body valves 50 mm and smaller shall have forged steel bodies. Forged steel valves complying with the standards and specifications listed in Table 126.1 of ANSI B31.1 shall be used within the manufacturer's specified pressure temperature ratings with the following limitations. The use of Class l500, 2500, and 4500 forged steel valves shall be limited in accordance with the pressure temperature ratings specified in ANSI B16.34, and the criteria established in MSS SP-84.

Class 800, 1500, 2500 and 4500 forged steel valves shall be constructed as follows: -

a) Class 800 valves shall have bolted bonnet joints. Class 1500, 2500 and 4500 valves shall have pressure seal, integral, or breech lock bonnet joints. Gate, globe, and angle valves shall have outside screw and yoke construction.

b) All valves, except gate valves, shall have seats of the integral type. Gate valves shall have renewable seats.

c) Class 1500, 2500, and 4500 valves shall be of loose back seat design.

d) Class 1500, 2500, and 4500 globe valves shall be of the Y-pattern type.

e) Valve ends shall be socket-weld type unless otherwise required.

f) Except as otherwise required, check valves shall be of the guided piston or swing disk type. All check valves shall be designed for installation in either horizontal piping or vertical piping with upward flow.

C. Steel Body Valves 65 mm and Larger

Steel body valves 65 mm and larger shall have cast steel bodies. The face-to-face and end-to-end dimensions shall conform to ANSI B16.10. The use of these valves shall be in accordance with the pressure temperature ratings specified in ANSI B16.34 as applicable.

Gate, globe, and angle valves shall be provided with back seating construction; and shall be of outside screw and yoke construction. Gate valves 100 mm and larger shall have flexible wedge disks. Split disks shall not be permitted. Valves shall have full size ports, except where venturi ports are specifically permitted to Engineer’s approval. The use of valves with venturi ports shall be limited to selected large diameter, high-pressure valve applications.

Class 150, 300, and 400 valves 65 mm and larger shall be constructed as follows: -

i) Bonnet joints shall be of the bolted flanged type having flat face flange facings for Class 150 valves; and male and female facings for Class 300 and 400 valves.

ii) Body ends shall be butt weld type unless otherwise required.

Class 800, 900, 1500, 2500, and 4500 valves 65 mm and larger shall be constructed as follows: -

i) Bonnet joints shall be of the pressure seal or breech-lock type.

ii) All Class 800, 900, 1500, 2500, and 4500 valves shall have grease-lubricated antifriction bearing yoke sleeves.

iii) Body ends shall be butt weld type unless otherwise required.

Check valves used on pump discharge installations, and on other applications in which the valves may be subjected to significant reverse flow water hammer or fluid surges, shall be of the non slam tilting disk type. All other check valves shall be of the guided piston, swing disk, or double disk spring check type. The use of double disk spring check valves shall be limited to 350 mm and larger cold-water services. All check valves shall be designed for installation in either horizontal or vertical piping with upward flow. Stop check valves, where specified, shall be Y-pattern globe type.

D. Iron Body Valves

Iron body gate, globe, and check valves shall have iron bodies with bronze trim. The face-to-face dimensions shall be in accordance with ANSI B16.10. These valves shall have flanged bonnet joints. Gate and globe valves shall be of the outside screw and yoke construction. Body seats shall be of the renewable type. Gate valves shall be of the wedge disk type. Lined cast iron body diaphragm and check valves used with lined piping shall be flanged body with liner and diaphragm material suitable for the service.

E. Butterfly Valves

Rubber-seated butterfly valves shall be generally constructed in accordance with AWWA C504 Standard for Rubber-Seated Butterfly Valves. The valves shall also generally conform to the requirements of MSS Standard Practice SP-67, Butterfly Valves. Valves of the wafer or lug wafer type shall be designed for installation between two ANSI flanges. Valves with flanged ends shall be faced and drilled in accordance with ANSI B16.1. The selected use of butterfly valves shall be in accordance with the pressure temperature ratings specified in AWWA C504, the pressure temperature ratings specified by the manufacturer as per the following criteria: -

a) Butterfly valves shall generally be used for 150 mm and larger cold-water services only.

b) Butterfly valves for buried service shall be of cast iron body material and shall be equipped with flanged ends.

c) Cast iron butterfly valves shall have pressure class selected based on the piping design pressure as follows:

	Piping Design Pressure	**Valve Class**
i)	1.8 bar and below	Class 25

ii)	Above 1.8 bar to 5.2 bar	Class 75
iii)	Above 5.2 bar to 10.3 bar	Class 150

d) Cast iron butterfly valves shall be limited to use with piping systems having a design temperature of 50 C or less.

e) Butterfly valves for other than buried service shall be of carbon steel or cast iron body material depending on the service application. Valves 600 mm and larger in size shall be equipped with flanged ends. Valves 500 mm and smaller in size shall be of the wafer type, or lug wafer type, if used with steel piping; and shall be flanged if used with other piping materials (cast iron, etc.).

f) Carbon steel butterfly valves shall be limited to use with piping systems having a design temperature of 65 C or less. Carbon steel butterfly valves shall have pressure class selected in accordance with the pressure temperature ratings specified in ANSI B16.34 for 600 mm and smaller valves. Valves 750 mm and larger in size shall be selected and specified based on the piping design pressure and temperature, without reference to a specific pressure class.

Metal seated or Teflon seal ring seated butterfly valves for special service applications shall be of the wafer or lug wafer type; and shall be designed for installation between ANSI flanges. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

F. Bronze Body Valves

Bronze gate and globe valves 50 mm and smaller shall have union bonnet joints and screwed ends. Bronze gate and globe valves used in control air service shall have brazed joint ends. Gate valves shall be inside screw, rising stem type with solid wedge disks. Globe valves shall have renewable seats and disks.

Bronze check valves 50 mm and smaller shall be Y-pattern swing disk type or guided piston type designed for satisfactory operation in both horizontal piping and vertical piping with upward flow.

Bronze valves 65 mm and larger shall have bolted flange bonnet joints and flanged ends. Gate and globe valves shall be of the outside screw rising stem construction. Gate valves shall have either integral or renewable seats. Globe valves shall have renewable seats.

The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer and in accordance with the criteria established in MSS SP-80. Bronze valves shall generally be Class 200, and shall be limited to service with piping systems having design pressures of 14 bar or less, and design temperatures of 65°C or less.

Bronze valves shall generally be limited to a size of 80 mm or less.

G. Plug Valves

Plug valves shall be of the eccentric, lubricated, or Teflon sleeve plug type, as required by the service. Plug valve bodies shall conform to the requirements of ANSI for dimensions, material thickness, and material specifications. Bonnets shall be of the bolted flange type. Body ends shall be flanged, faced, and drilled

for installation between ANSI flanges. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

H. Ball Valves

All ball valves shall have full area ports, Teflon seats & seals, and chrome plated carbon steel or stainless steel balls. Ball valve bodies 50 mm and smaller shall have threaded end connections. Ball valves 65 mm and larger shall have flanged ends. The valves shall not require lubrication. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

I. Check Valves

These shall be swing check type with material of construction as given above. The body shall be of cast iron with flanged ends.

J. Flow Regulating-Cum-Measuring Valves

These are special valves to be installed at the outlet of each cooling coil/heating coil as shown in drawings. The Contractor shall also supply measurement it including manometer. The valves shall be of variable orifice design double regulating type. The valve shall have measurement ports for connecting the manometers. The Contractor shall supply all calibration charts etc. The valve shall have provision for locking at pre set flow condition and it shall be possible to close the valve and again open up to this pre set point. The valves shall be of gun-metal/bronze construction.

K. 3-Way Mixing Valves

These are special valves to be installed at the outlet of each AHU heating coil as shown in drawings. The motor shall be actuator based controlled. The valve shall operate from the sense of the room thermostat. The Contractor shall also supply measurement kit including manometer. The valves shall be of variable orifice design double regulating type. The valve shall have measurement ports for connecting the manometers. The Contractor shall supply all calibration charts etc. The valve shall have provision for locking at pre-set flow condition and it shall be possible to close the valve and again open up to this pre set point. The valves shall be of gunmetal / bronze construction.

L. Refrigerant Valves

All refrigerant valves as may be applicable shall have Brass body with flange connection or sweat connection for welding or brazing to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. The valve body and bonnet connection shall have bolted and welded connection.

It is preferable to have Teflon gland packing for the valves construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak proof-ness of the valves shall be tested at

minimum 1.5 times the design pressure for the system but not less than 35 Kg / Sq. Cm.

6.08.00 **Air Handling Equipment**

6.08.01 Air Handling Units

A. FAN

The fans shall be forward/backward curve bladed centrifugal type. The number of fans per unit shall be as per standard of the manufacturer. The impeller and the scroll casing of the fans shall be made of steel and protected with suitable painting as per Manufacturer's standard.

The fan shaft shall be of Carbon steel. Bearing shall be heavy-duty self-aligning type. The fans shall be dynamically balanced. The motor shall be adequately rated to prevent overload.

B. DRIVE

Centrifugal fans shall be equipped with V-belt drive and belt tensioning arrangement. All belts shall be sized with 1.1 service factor. All belt drive shall be equipped with removable guards to avoid accidental hazards. There shall be a minimum of two belts per drive.

C. DRY FILTER

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filters shall be of dry panel type. The filter shall have G.I. frames of adequate thickness but not less than 20 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

D. COOLING COIL

The cooling coil for chilled water shall consist of seamless copper tubes with aluminium fins. There shall be preferably only one cooling coil per AHU or as per manufacturer's standard.

The cooling coil for chilled water plant shall be equipped with manually - operated flow regulating valve with provision for flow balancing at site to control the chilled water flow. This cooling coil shall be designed for chilled water / air duty. Counter-flow process of heat transfer shall be considered in the design requirement. The flow factor of 0.001 Hr. Sq. Ft. - ℉ / BTU (0.0002 hr - Sq. M ℃ / Kcal) shall be taken in the design of the cooling coil. Number of rows shall be minimum 4 and shall follow even number for any

particular coils to facilitate connection of water/refrigerant only on one side of the unit.

Fin design shall be chosen for the duty to be performed with special attention to the possibility of lint accumulation. However, in any case, number of fins in the coils shall not exceed 13 / Inch. Velocity of air across the coils shall be limited to 2.5 m/sec.

In case of chilled water-cooling coil, arrangement for air purging and water draining from the coil is to be provided.

E. CASING

a) The casing shall be of double skin type GI with at least 25mm thick PUF insulation (density approximately 35Kg/ M^3) in between two skins (made of 24 G GI sheet) and complete with supply air outlets with volume control dampers and flexible connections, structural frame work with supports and serrated rubber pads as vibration isolators and shall be provided with thermal break at the joints of different sections. Outer skin of the AHU shall be powder coated.

b) Base frames shall be supplied for floor mounted type units. Drain pans shall be in SS-304 construction having at least 65mm depth and shall be fabricated in such a way to form the slope towards drain point.

c) The main structure of the Unit (i.e. framework) shall be in extruded aluminium construction. The structural members shall have industrial anodized finish to form scratch proof, corrosion resistant, smooth finish surface. The structural member shall have a thermal break between inner & outer surface to minimize heat loss. The sealing surface of the extrusions shall be provided with the groove to hold the gasket. The gasket shall be of synthetic construction having tubular shape for proper sealing. The inner face of the panels shall be flushed with inner face of the extrusions to minimize the corners.

d) Panels of the casing shall be fitted reasonably airtight with suitable gaskets with cams or similar fastenings for easy opening.

e) Necessary arrangement shall be provided on the casing for measuring temperature and pressure in a cooling coil.

f) Easily open able inspection doors shall be provided at required locations for easy maintenance. The Doors shall have handles and hinges in glass filled nylon construction.

g) The Lock shall be flushed type to minimize projections. Locks shall have proper arrangement to secure the doors tightly.

6.08.02 Fan Coil Units

A. The fan coil units shall be of reputed make – horizontal type for ceiling suspension. The units shall be complete with chilled water coil, one or more centrifugal fans and motors, cleanable HDPE filters, double wall insulated condensate drain pan with 15 mm thick expanded polystyrene (self extinguishing quality) insulation sandwiched between top and bottom sheets of drain pan and 18 gauge sheet steel casing panels. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pans.

B. Access panels shall have positive locking fasteners for easy removals. The filters shall be mounted at the rear section of the cabinet with filter box.

C. All cooling coils shall be standard three row staggered seamless copper tube with aluminium plate fins mechanically bonded to copper tubes. Tubes shall be aluminium 10 mm 0.D. and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within the insulated end sections of the base unit for protection against sweating. Each coil shall be provided with an air vent and drain plug. All coils shall be factory tested at 21 kg. Per Sq. cm. air pressure while submerged in water. Fin spacing shall not be less than 10 fins per inch. Tubes shall be mechanical / hydraulically expanded for thermal contact resistance with fans.

D. Fans shall be centrifugal, forward-covered, and direct driven by shaded pole motor.

E. All fans coil units shall be equipped with copper piping connection and manual air vent at the cooling coil. 0ther accessories shall be wall mounted thermostat for individual unit, containing two speed and ON / Off control for fan speed, motorized there-way diverting/mixing valve for individual unit, Y-strainer, ball valve and globe valve, adjustable discharge air grilles.

F. The fan coil unit shall be selected for the lowest operating noise level. It should offer capacity at the lower speed.

6.09.00 **Air Filters**

6.09.01 Pre-Filters

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filters shall be of HDPE construction. The filter shall have G.I. frames of adequate thickness but not less than 20 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

6.09.02 High Efficiency Filters

The filters shall be having efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall not exceed 1.5 m/sec.

High efficiency filters shall be provided with differential pressure switch with alarm.

6.10.00 **Duct Work**

6.10.01 Velocity of air in any section of the supply duct shall not exceed 8 m/sec.

6.10.02 Sheet metal thickness for AC duct shall conform to IS-655.

6.10.03 The general layout of the ducting location and number of air grilles and diffusers etc. shall conform to the specific requirements of individual areas of application so as to ensure proper air distribution of all the zones. The same shall be subject to approval by the Engineer.

6.10.04 Where dimensional locations are not indicated on the drawings, the Contractor will be responsible for the final arrangement and routing of the ductwork. Variations in duct sizes may be made as acceptable to the Owner if the cross-sectional area remains the same and the revised aspect ratio is less than four. Ductwork will be arranged to minimize pressure drop using low-loss fittings and transitions. Where radius elbows are used for duct turns, the radius ratio will not be less than 1.5 wherever possible. Where space limitations require a bend with a radius ratio of 0.75 or less, not less than two turning vanes will be installed in the bend.

6.10.05 All ductwork for supply of air inclusive of accessories such as damper, vanes, access doors etc. shall be fabricated from G.I. sheet of at least grade 180 as per IS 277 or aluminium sheet. 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.

6.10.06 The construction of ducts shall conform to IS : 655/ASHRAE/SMACNA as far as applicable, unless otherwise stated here.

6.10.07 JOINTS

a) All longitudinal joints for the ducts will be Pittsburgh Lock seam type.

b) Transverse joints for the low-pressure ducting shall be continuous around the four sides, the corner closure are required. The type of transverse joints shall be as follows:

Large side mm	Type of transverse joints
Up to 600	25 mm wide pocket, drive or S-slip
601 - 1000	85 mm wide, bar s-slip or pocket slip
1001 – 2250	40 mm x 40 mm x 6 mm M.S. angle connection

c) The low-pressure ducting work shall be provided with intermediate transverse bracing continuous around the four sides between the joints according to the following sizes:

Large side mm	Bracing
0 - 450	None
451 - 1500	40 mm x 40 mm x 6 mm angle 1200 from joints.
1501 and above	40 mm x 40 mm 6 mm angle 600 mm from joints.

d) Riveting and Sealing

All joints, slips and seams shall be made secure by reverting on centres not exceeding 150 mm. All transverse stiffeners and all reinforced bar slip joints shall cross at corners and be riveted. All bar slip joints and angle iron bracing shall be riveted on centres not exceeding 75 mm.

e) All construction joints and duct seams shall be reasonably sealed with bitumastic cold emulsion or equivalent vapour seal.

6.10.08 Hangers and Supports

a) All ductwork shall be provided with adequate hangers or supports to ensure rigid support and to prevent vibration. Spacing of duct supports shall not exceed 3 m centres.

b) Hangers shall be suspended from the building steel with provision for necessary auxiliaries, or special steel members, or by hooks fixed to the embedded plates provided in the ceiling.

c) Hangers for all ducts shall be trapeze type with the shelf construction from 35 mm x 35 mm x 5 mm angle iron and hung by two steel rods each of not less than 10 mm dia. for ducts, with larger side less than

2250 mm while for those greater than 2250 mm shall be with 50 x 50 x 5 angles and rods not less than 16 mm dia.

d) All hangers and supports shall be as per drawings / specifications. When vertical ducts pass through floor slab, they shall be supported by means of collars, constructed of steel structural angles securely fastened about the girth of the duct and bitumastic compound between the horizontal leg of the supporting angle and the floor. The duct aspect ratio shall not be more than 4: 1. Turning vanes are required to be provided with bend more than 45 Deg.

6.10.09 Access Doors

All main ductwork shall be accessible throughout using tight fitted hinged access doors. Doors shall have to be cemented on sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.

Access doors/panels are to be provided at following places:

Near each fire damper
Near each heater coil
Near each filter bank

In case access doors are to be installed in the insulated ducts, the access door panel should be suitably insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the duct when the plant is running.

6.10.10 Flexible Connection

Rubber impregnated canvas or equal flexible connections of at least 150 mm length shall be provided at each connection between ductwork and fan units.

6.10.11 Dampers

i) SPLITTER DAMPER

Splitter dampers in branch take off shall be provided. Dampers blades shall be minimum 16 SWG thick. Alternatively catcher shall be provided in right angle tee of ducts.

ii) FIRE DAMPER

Fire dampers shall be provided as per the requirement mentioned elsewhere in the specification. The fire dampers shall be of motorised / solenoid/fusible link type operated by smoke detectors of the zone fire fighting system. The fire damper shall be smoke-tight type and shall have 120 min. fire rating. Provision shall be kept for manual operation of the damper.

Blade thickness	:	At least 16G CRCA
Frame	:	At least 40 x 40 x 3 mm Angle.

Motorised Fire Dampers shall be rated for 240 V, 50 Hz, 1 Ph., AC supply. Motor for Fire dampers shall be continuously rated. These Dampers shall close on de-energisation and open on energisation of Motor. Provision shall be kept for manual operation of the Damper.

Fire dampers will be provided at the supply/exhaust duct for fire-rated walls/floors as required by National Fire Protection Association (NFPA) and International Building Code (IBC).

iii) ACTUATORS

The actuators will be UL listed.

Dampers will be equipped with operators of sufficient power to control dampers, without flutter or hunting, through the entire operating range at air velocities at least 20 percent greater than maximum design velocity. Operators will have sufficient power on closure to provide tight sealing against maximum system pressures. Damper actuators will be designed to provide a minimum of 200 percent of the torque required to operate the damper and to meet the air leakage criteria. Damper actuators will not be less than 2.26 N-m (20 inch-pounds). Each damper section will contain one or more damper actuators. Jack-shafting of the section is not permitted.

Operators functioning in sequence with other operators will have adjustable operating ranges and set points.

Spring-return operators will be provided for two-position control or on reversible operators where required for fail-safe operation.

Electric motor operators for modulating control will be reversible type.

Locations where temperatures fall below minimum operating temperature of operator will be heated.

When dampers are installed on ducts to be externally thermally insulated, each damper operator will be equipped with stand-off mounting brackets, bases, or adapters to provide clearance between the duct and operator not less than the thickness of insulation. Standoff mounting items will be integral with the operator or standard accessory of damper manufacturer.

iv) OPPOSED MULTIPLE LOUVRE DAMPER

Opposed multiple louvers dampers shall be provided at the fan outlets and wherever mentioned in the drawings, specification and fan schedule. Each blade of the dampers shall be provided with bronze, gunmetal or nylon bearing at each end of its spindle. The spindle with bearing shall be mounted in a strong structural framework. Operating lever with fixing device for keeping the damper at the desired position shall be fitted for the manually operated dampers.

Operating level will be fixed on an indicator to show the percentage of opening of the damper in all cases except for the application with grilles and nozzles.

Velocity across the dampers shall not exceed 10 m/sec. Damper blades at fan outlet shall be made up of 16 gauge M.S.

6.10.12 Diffusers, Grilles, Registers - Conventional Design

Design of grilles & diffusers shall be such as to create desired throw and spread of air and shall be approved by the purchaser/engineer.

All diffusers and grilles shall be made up of powder coated sheet steel / extruded aluminium with finish painting. Design of all diffusers and grilles shall be made by the Contractor matching with the lighting and other fittings and to be approved by the Engineer. Each supply air diffusers shall be fitted with opposed blade damper, built-in vanes and louvers arranged as per manufacturer's standard design.

Side throw type supply registers shall have two sets of adjustable louvers with opposed blade dampers. The front of louvers shall be horizontal to provide horizontal deflection and the rear set of vertical louvers shall adjust vertical deflection. The dampers shall have horizontal opposed blades regulated by an operating lever in the frame. All wall type exhaust / return air grilles shall have one set of louvers in the front. The louvers shall be fitted such as to remain in position by friction grip. All supply air grilles shall have one set of opposed multiple louver dampers at the inlet. The dampers shall be gang operated and will have a device to keep the dampers fixed in one position.

The grille frame and louvers shall be manufactured of at least 20 SWG GI sheet and 22 SWG M.S. respectively. No grilles should by any chance make any rattling sound during continuous operation. All grilles shall match the decor of the space.

All grilles/diffusers shall be fitted with suitable gasket to prevent air leakage.

6.11.00 **Insulation**

6.11.01 Thermal Insulation

A. The following items are to be insulated:

I. Refrigerant suction piping from the evaporator coil outlet up to the compressor inlet shall be insulated with minimum 39 mm thick aluminium foil faced Nitrile rubber/ XLPE for Screw type Package Water Chilling Unit and 26 mm Nitrile Rubber/XLPE with 30G Aluminium sheet Cladding for Precision/ Split Air Conditioner. For better efficiency of operation the liquid line running side by side with the suction line may be insulated together with the suction line already mentioned.

II. Double skin Casing of the cabinet type air-handling unit with at least 25 mm thick Poly Urethane Foam (PUF)/ EPS sandwiched between them.

III. Supply air duct and part of the return air duct passing through non conditioned space, if any, with at least 13mm thick aluminium foil faced Nitrile Rubber / XLPE Insulation.

IV. Entire chilled water-piping, valves, chilled water circulating pumps, and chillers with 39 mm thick aluminium foil faced Nitrile rubber/XLPE.

The portion of Chilled water piping exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene and finished with chicken wire mesh, 12 mm thick sand-cement plaster and an overall cladding of 30G Al. sheet.

V. Drain Piping from AHU/Precision ACs /Split AC unit/ FCU and Chillers shall be insulated with 13 mm/ 6mm (for FCU and Split units) thick aluminium foil faced Nitrile Rubber/ XLPE.

VI. Screw type Packaged Chiller and Chilled Water Pump shall be insulated with 39 mm thick aluminium foil faced Nitrile Rubber/ XLPE.

VII. Chilled water Expansion tank drain piping with 6 mm thick aluminium foil faced Nitrile Rubber/XLPE.

VIII. Insulation of Precision AC Unit/ Split AC Unit shall be as per manufacture's standard.

IX. Roof of AC spaces shall be insulated with 25 mm thick EPS (under deck) for not exposed to sun and 50mm thick EPS (under deck) for exposed to sun.

B. Insulation shall be fixed as per manufacturer's recommendation. Due care shall be taken to avoid damage to vapour arresters and insulation.

C. Extra insulation thickness shall be provided at duct pipe hangers and special care shall be taken to seal the insulation and hanger member penetrations and instruments and accessories tapings.

D. Special care shall be taken to provide satisfactory insulation for valves, flanges, vessel connections etc. with proper facility for maintenance and inspection.

E. Insulated ducts crossing the floors shall have to be normally protected from damage and water splashing by providing suitable cladding up to 300 mm from the floor level.

6.11.02 Acoustic Insulation

All supply air ducts in the air conditioning system shall be insulated with Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner.

6.12.00 **Precision / Split AC Units**

6.12.01 Water Cooled Precision Air Conditioners

A. Compressor

The compressor shall be hermetically sealed scroll type medium speed, single acting type designed for R-407C/410A duty. The compressor shall be complete with crank case heater (to be energised when compressor is on off cycle).

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

B. Condenser

All condensers shall be of shell and tube type with water in the tubes and refrigerant in the shell.

The heat exchanger shall be designed for a minimum working pressure of 10.5 kg/cm^2 gauge on the water side and 19.0 / 27.0 kg/cm^2 for R-407C / 410A on the refrigerant side and shall generally conform to the latest ASME CODE for unfired pressure vessels Section- VIII. The design pressure shall have a reasonable margin over the maximum working pressure.

The average velocity of water in tubes shall not be more than 2.5 m/sec.

Water heads or refrigerant heads of the heat exchangers shall be as not to allow leakage of fluid from one pass to the other.

Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating.

The overall fouling factor for the condensers shall be 0.0002 Hr.M^{2o}C/K.Cal.

The condensers shall be designed to provide at least 2 ℃ sub cooling of refrigerant under rated design condition.

Testing and other design feature of the heat exchanger shall meet the requirements of TEMA Class-C heat exchangers or approved equal.

The heat exchangers shall have open able water boxes for ease in maintenance.

The tubes for the condensers shall also be copper with integral fins. The tube wall thickness at any point shall not be less than 18 SWG.

The baffle plates and the tube sheets shall be made of steel. The shell shall be made up of seamless tube or shall be fabricated from flange quality steel plate (ASTM-A285 Grade-C). The tube support plates shall be made of flange quality carbon steel plates and shall be as per TEMA Standard.

The heat exchangers shall be provided with vent valve, relief valve, and/or safety fusible plug on refrigerant side and vent valve and drain valve on water side (at every section of the baffled shell of heat exchanger).

The tenderer shall quote packaged units having compressor, condenser and evaporator assembly together in a single framework and mounted on a common base plate. Provision for refrigerant charging and chemical cleaning of water tubes shall be provided.

Each heat exchanger shall be provided with water flow switch. This shall be interlocked with the control of the individual refrigeration system/ corresponding compressor drive.

All the heat exchangers shall be provided, with standard connections like thermo wells, inspection valve and antifreeze thermostat and external equaliser connection for expansion valves. Insulation shall be terminated in such a manner that it will not be damaged during removal of bolts, covers etc. Separate covers similar to flange covers shall be constructed to facilitate easy removal.

The design pressure shall have a reasonable margin over the maximum working pressure.

C. Evaporator Cooling Coil

The cooling coil shall be direct expansion type with multi-row deoxidised copper tubes with aluminium fins. Air velocity across the coil shall be limited

to 2.5 m/sec. The coils shall be pressure tested and thoroughly dehydrated before assembling.

The coil shall be placed to make the system draw through type. Refrigerant feed control shall be by electronic expansion valve. Temperature control shall be through microprocessor based control panel. Insulated condensate drain pan of SS construction shall be provided within the unit.

The unit shall be factory assembled, wired, with inter connecting refrigerant piping and built-in microprocessor based control console and tested as per the relevant code.

The cooling coil shall be to produce the capacity required under specified coil condition and air quantity. Heat load calculation to check the system selection shall be carried out and submitted by the tenderer.

D. Evaporator Fan

The fan shall be heavy duty DIDW centrifugal type statically and dynamically balanced with forward/backward curve blade, directly driven by high efficiency EC motors. Fan wheels and casing shall be constructed of steel and mounted on steel shaft. The bearings shall be ball bearing type mounted on vibration absorbing rubber mounts. The fan motor shall be mounted within the cabinet. Motor horsepower shall be sized for 120% of the rated power required.

The supply fan shall be sized to deliver the required air quantity against the total external static pressure required for the system application, after taking care of all internal static pressure requirements of the units.

E. High Efficiency Filter

A set of High efficiency filters will be located inside the PAC unit cabinet. The filters shall be high efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling them.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall preferably not exceed 1.5 m/sec.

F. Humidifier

The humidifier shall be of Electrode type and shall be placed inside the PAC unit cabinet. The humidifier shall be electronically controlled through the built-in microprocessor based control panel of the unit. A provision of make-up water connection with the humidifier shall be kept with the Unit cabinet.

G. Electric Strip Heater

The PAC unit will be provided wit built-in electric strip heater electronically controlled through the built-in microprocessor based control panel of the unit.

Such control includes both operating and safety controls with the sense of air temperature at the RA path and at the downstream side of the heater respectively.

H. Casing and Cabinet

All components shall be housed in a welded sheet metal cabinet of double skin of not less than 22 G thick MS powder coated sheets. The gap between two skins is filled up with at least 25mmthick PUF/ EPS insulation. Different sections will be constructed with framework and connected with each other in an airtight manner through gaskets, thermal barriers and sealant.

Removable panels shall be constructed of framed 1.6 mm sheet steel with angle iron framing. Units shall be provided with 316 L.S.S. fasteners for easy removal and access for servicing. Air handling section of evaporator shall be provided with an acoustic lining of 25 mm thick fiberglass covered with fiber glass cloth and perforated aluminium sheet on the inside surface of the unit casing.

The return air opening shall be on the front face with a matching grille of same colour finish.

6.12.02 Air Cooled Precision Air Conditioners

A Compressor

The compressor shall be hermetically sealed scroll type medium speed, single acting type designed for R-407C/410A duty. The compressor shall be complete with crank case heater (to be energised when compressor is on off cycle).

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

B Condenser (Outdoor Unit)

The Condenser shall be of Air Cooled type and shall be constructed of copper tube with aluminum fins. Tubes shall be designed for a minimum working pressure of 30 kg/ sq. cm. The condenser shall be complete with

fans with drive motors and shall be provided with charging connection, safety relief valve and standard accessories, all encased in a powder coated GI casing with built-in electrical items and supporting frame. The condenser shall have the matching capacity with the compressor. There shall be a provision of isolating switch for the fans.

C Evaporator Cooling Coil

The cooling coil shall be direct expansion type with multi-row deoxidised copper tubes with aluminium fins. Air velocity across the coil shall be limited

to 2.5 m/sec. The coils shall be pressure tested and thoroughly dehydrated before assembling.

The coil shall be placed to make the system draw through type. Refrigerant feed control shall be by electronic expansion valve. Temperature control shall be through microprocessor based control panel. Insulated condensate drain pan of SS construction shall be provided within the unit.

The unit shall be factory assembled, wired, with inter connecting refrigerant piping and built-in microprocessor based control console and tested as per the relevant code.

The cooling coil shall be to produce the capacity required under specified coil condition and air quantity. Heat load calculation to check the system selection shall be carried out and submitted by the tenderer.

D. Evaporator Fan

The fan shall be heavy duty DIDW centrifugal type statically and dynamically balanced with forward/backward curve blade, directly driven by high efficiency EC motors. Fan wheels and casing shall be constructed of steel and mounted on steel shaft. The bearings shall be ball bearing type mounted on vibration absorbing rubber mounts. The fan motor shall be mounted within the cabinet. Motor horsepower shall be sized for 120% of the rated power required.

The supply fan shall be sized to deliver the required air quantity against the total external static pressure required for the system application, after taking care of all internal static pressure requirements of the units.

E. High Efficiency Filter

A set of High efficiency filters will be located inside the PAC unit cabinet. The filters shall be high efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling them.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall preferably not exceed 1.5 m/sec.

F. Humidifier

The humidifier shall be of Electrode type and shall be placed inside the PAC unit cabinet. The humidifier shall be electronically controlled through the built-in

microprocessor based control panel of the unit. A provision of make-up water connection with the humidifier shall be kept with the Unit cabinet.

G. Electric Strip Heater

The PAC unit will be provided wit built-in electric strip heater electronically controlled through the built-in microprocessor based control panel of the unit.

Such control includes both operating and safety controls with the sense of air temperature at the RA path and at the downstream side of the heater respectively.

H. Casing and Cabinet

All components shall be housed in a welded sheet metal cabinet of double skin of not less than 22 G thick MS powder coated sheets. The gap between two skins is filled up with at least 25mmthick PUF/ EPS insulation. Different sections will be constructed with framework and connected with each other in an airtight manner through gaskets, thermal barriers and sealant.

Removable panels shall be constructed of framed 1.6 mm sheet steel with angle iron framing. Units shall be provided with 316 L.S.S. fasteners for easy removal and access for servicing. Air handling section of evaporator shall be provided with an acoustic lining of 25 mm thick fiberglass covered with fiber glass cloth and perforated aluminium sheet on the inside surface of the unit casing.

The return air opening shall be on the front face with a matching grille of same colour finish.

6.12.03 Non-Duct able Split Type Air Conditioning Units

A. General

I. The split type room air conditioner consists of two units one Indoor unit (Evaporator) & an Outdoor unit (Condenser). It will be complete with all components to perform filtering and cooling of air in all seasons except winter. The refrigerant condenser will be air-cooled. The unit will be suitable for wall mounting.

II. The unit shall have normal rating capacity as per the schedule mentioned elsewhere in the specification measured at a room temperature 24 ℃ DB and RH not exceeding 65% under design outside conditions specified elsewhere. The capacity variation should not be more than 5%.

B. Indoor Unit

I. The indoor unit consists of panel type dry filter, cooling coil, evaporator fan etc.

II. The filter is panel type dry having an efficiency of 90% down to 10-micron size Particles. The filter media shall be designed to hold dust, sand and prevent if from being dislodged by vibration or other cause and passing through filter. The face velocity of air across the filters shall not exceed 2.5 m / sec.

III. Cooling coil will be direct expansion type made of seamless copper tubes with aluminum fins, number of fins as per manufacturer's standard but not more than 13 per inch & R22. The coils should be located at the suction side of the Evaporator Fans. Velocity of air across the coils shall be limited to 2.5 m/sec.

IV. Piping accessories like Hot gas piping, cold gas piping and liquid refrigerant pipeline all made of copper complete with at least 26 mm thick Aluminium foil faced Nitrile rubber / XLPE or equivalent insulation interconnecting indoor and outdoor units, liquid line valves, liquid refrigerant piping, gauges and instruments, filter-drier, moisture indicator, isolating valves etc., shall be provided as may be required for safe and trouble free operation.

V. The evaporator fan shall be Centrifugal, DIDW with forward Curved blades directly driven by TEFC squirrel cage induction motor operating in AC 240 V ± 10%, 1 Ph, 50 Hz ± 5% supply, with 3- step speed control. The evaporator fan shall be both statically and dynamically balanced.

VI. Sheet metal casing with inspection facilities, made of Powder coated M.S. sheet and complete with suitable refrigerant pipe connections, insulated drain pan, insulated drain piping, supply and return air opening with decorative grilles with automatically swiveling louvers (for supply air grilles). The casing should be insulated inside to prevent condensation. This shall be provided from inside surface to limit the noise.

C. Outdoor Unit

I. The outdoor unit shall consist of a compressor, air cooled condenser with liberally sized aluminium finned copper tube coil and low noise directly driven fan and totally enclosed weather proof motor housed in power coated MS casing.

II. The Compressor shall be rotary type with R-22 refrigerant of specified capacity & motor. The compressor assembly shall be adequately designed for minimum vibration and noise disturbances. The compressor rotor assembly shall be dynamically balanced. The shaft seal shall be of proven design. The horsepower for the compressor motor shall be sized for 115% of rated power required for the unit including the drive loss.

III. Accessories like Suction and discharge valves, safety valve, HP and LP cut out switches, powder coated sheet metal casing, vibration-isolating device, foundation bolts, built in Electricals like starters, switch fuse units, relays, contactors. The speed of the compressor should not exceed 1500 rpm.

IV. Air-cooled condenser with directly driven axial flow fan & adequately sized drive motors (TEFC squirrel cage Induction type) with relief valve, hot gas connection, charging connection with valve, louver at the intake & exhaust of air, and other standard accessories. The condenser fan shall be both statically and dynamically balanced.

V. The heat exchangers shall be designed for a minimum design test pressure of 20.33 Kg/m^2 on the refrigerant pipe. The design pressure shall have a reasonable margin over the maximum working pressure. Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating. The condensers shall be designed to provide at least 4^oC sub cooling of refrigerant under rated design condition. The unit should be operating free from any vibration and noise.

VI. The piping will be thermally insulated wherever required such that there is no condensation on the outside of the piping. The insulation will be of Aluminium foil faced XLPE or Nitrile rubber or equivalent.

VII. Refrigerant piping shall be either of M.S. seamless (as per IS-1239, Part-I heavy grade) or copper tube (IS-5493) or ASA-9-31.5). Pressure drop in hot gas, liquid and suction lines should not exceed the value corresponding to 2 ^oF change in saturation temperature of the refrigerant. Velocity in the discharge and suction pipe of the refrigerant shall not be so high as to create undue vibration and noise, velocity in the vertical length of discharge and suction pipe of the refrigerant shall be high enough to carry the entrained oil in the refrigerant, even in case of unit running at lowest partial capacity. Instrument piping for gauges, switches etc. shall be of copper only.

VIII. All the above equipment along with the electrical items like starter, contactor and other controls shall be encased in a powder coated MS casing. The casing shall be complete with supports fabricated out of MS angles, & sheets (duly painted), anchor bolts, nuts etc. The entire unit shall be installed with rubber pad type vibration isolators.

IX. All refrigerant valves as may be applicable shall have steel or brass body with flange connection or socket connection for welding or brazing to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. It is preferable to have the stems of rising stems inside screw type. The valve body and bonnet connection shall have bolted or welded connection.

X. It is preferable to have Teflon gland packing for the valves. The construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak tightness of the valves shall be tested at minimum 1.5 times the design pressure for the system.

6.13.00 **Fresh Air System**

6.13.01 For critical areas like control room, control equipment room etc., outside fresh air will be inducted into the AHU room/ PAC room through a Fresh Air system consisting of an inlet louver, dry panel type filter, a fan with a short duct (if necessary), SA register and mixed with the return air in AHU room/ PAC room.

For other non-critical areas like service building fresh air will be inducted in the AHU room through the wall mounted rain protection cowl with bird screen and a volume control damper.

6.14.00 **Miscellaneous Items**

6.14.01 Heater

A. Strip heater

I. Heating equipment wherever required shall be electrical type. All frame members, control box cover and associated sheet metal parts are to be heavy gauge steel with corrosion resistance treatment. Heating equipment may be required for winter heating as well as for reheating. Reheating heaters may be used for winter heating also.

II. Electric heaters will be fin-tube type of specified KW rating, with fins permanently brazed to metal sheath. The metal sheath and fins will be of G.I. sheet material.

III. Wherever electric heaters are installed in the ductwork, size of ducts should be suitably increased to offset the additional resistance created by the heaters. All heaters shall be mounted on such insulators that there shall be no leakage current under all weather condition including high humidity operation. The mounting frame shall be suitably grounded by earth wires / earth leads of two points.

IV. An air stat is to be installed such that in case there is no circulation of air over the heater coils the heaters will be de-energised. Wherever the heaters are installed in the ductwork the terminal block will be such positioned in a junction box that it will be outside the ductwork in an accessible position. The junction box will be vermin proof, rat proof and provided with a hinged cover. A caution plate as per I.E. rules will also be provided. Access door will be provided in the duct near the heating coil for easy inspection and removal / replacement / fixing of individual strip heaters. The capacity of heaters will be distributed over three phases.

V. In case of reheating the heater will be controlled by humidity sensor & humidity transmitter and in case of winter heaters it will be controlled by temperature sensor & temperature transmitter.

B. Electric Room Heater

Electric Room Heaters shall be with High / Low control.

Electric Room Heaters shall be suitable for AC 240 V ± 10%, 1 Ph, 50 Hz ± 5% supply.

6.14.02 Electrode Humidifier

A. Electrode humidifier consists of high temperature Polypropylene water tank, electrodes, auto flash cycle activated on demand from the microprocessor based control system with humidity sensor, located in the AHU / PAC room. Such Humidifier shall be controlled by its own stand-alone microprocessor based control panel. Alarm indication will be provided for low water level in the water tank.

B. Whenever the relative humidity of the conditioned space reaches the minimum allowable percentage of humidity, the humidifier shall be energized to restore the relative humidity. The humidifier shall be such controlled that it shall not exceed the maximum allowable limit of relative humidity in the conditioned space. The humidifier shall be sized and designed accordingly.

6.14.03 Non Chemical Water Treatment Equipment

A. The water treatment equipment is a 1 M long pipeline, which once installed, stops the formation of scale in the heat exchange zones completely.

B. The water treatment equipment consists of Metal Cell and Core and is installed on line after the pumps and before the heat exchange zone. The distance of the heat exchange zone should not be more than 30 M and there should not be any static area between the water treatment equipment and heat exchange area.

6.15.00 **False Ceiling**

6.15.01 Scope

The work under this Section shall include the supply and installation of suspended ceiling using GYPSUM boards together with the suspension system as shown on drawing or specified in Schedule with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or instructed by the Engineer.

6.15.02. Installation

A. Suspension System

General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

Metal Grid Suspension System

Aluminium grid ceiling system shall be "Beadlock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be jolly snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by MS flats, angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces & end tees shall rest on the moulding, unless otherwise shown on drawings.

B. CEILING PANELS

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V-joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and

schedule of items, 6 mm thick cement: lime: sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

6.15.03 Acceptance Criteria

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.15.04 Rates

Shall be lump sum rates for complete items called for in the "Schedule of Items". No extra payment will be made for arrangement for lighting fixtures, air conditioning diffusers, access panels, etc. The rate shall include all cutting and wastage from standard size sheets, boards, runners, etc.

6.16.00 **Electrical Items**

6.16.01 General Electrical Specification

For detailed General Electrical Specification, relevant Electrical section, as applicable, shall be followed.

6.16.02 Drive Motor

For detailed technical specification of motors, relevant Electrical section, as applicable, shall be followed.

6.16.03 Local Push Button Station (LPBS)

For detailed technical specification of Local Push Button Station (LPBS) system relevant Electrical section, as applicable, shall be followed.

6.16.04 Power Distribution Board

For detailed technical specification of Power Distribution Board relevant Electrical section, as applicable, shall be followed.

6.16.05 Cables

For detailed technical specification of Cables relevant Electrical section, as applicable, shall be followed.

6.16.06 Cable Trays and Racks

For detailed technical specification of Cable Trays relevant Electrical section, as applicable, shall be followed.

6.16.07 Grounding

For detailed technical specification of Grounding relevant Electrical section, as applicable, shall be followed.

6.17.00 **Controls & Instrumentation**

6.17.01 Control System

A. All control shall be electrical / electronic type depending upon the requirement & as specified under the specification.

B. Chilled Water System Controls

All safety controls against high refrigerant pressure, low refrigerant pressure, low oil pressure, high and low voltage, compressor over-load and protection against freezing of the water chiller, low flow condenser cooling water & chilled water shall be provided.

All safety controls against antifreeze protection, pump cavitations, motor protection etc. shall be provided.

Operating thermostat/ temperature sensor sensing outlet water temperature of chiller shall be provided for each compressor. This thermostat/ temperature sensor shall control the liquid line solenoid valve in conjunction with the capacity controller for Screw type. Automatically operated heaters with safety thermostats & automatic unloaded starting device shall be provided for the compressor. Antifreeze thermostat to trip off respective compressor shall be provided for each compressor.

C. Direct Expansion System Controls

All devices for automatic refrigerant flow control by thermostatic expansion valve sensed by the superheat in suction line, solenoid valves in the liquid line to operate in conjunction with automatic capacity control of compressor by room thermostat (as applicable) sensing from the inside temperature of the

conditioned space is to be provided. High pressure and low-pressure cut out, low oil pressure cut out (if applicable), high and low voltage protection, compressor motor overload protection shall be provided. Automatically operated crank case heater with safety thermostats shall be provided for reciprocating compressors.

D. Air Handling Unit Controls

The temperature of all conditioned spaces shall be maintained / controlled by a modulating type 3 way mixing valve. The modulating motor will be operated by getting sense from the temperature sensor and associated transmitter placed in the return air path. There shall also be control valves in the chilled water line (for chilled water units) for manual control of chilled water flow into the cooling coil. These control valves shall be flow regulating cum measuring type with precision adjustment arrangement.

E. Annunciations

Audio-visual alarm facility is envisaged of the system. Details of the annunciation system shall be as per mentioned elsewhere and as per requirement.

6.17.02 **Miscellaneous Instruments**

A. The pressure indicators and temperature indicators shall have minimum 150 mm size dial. The pressure gauges shall be Bourdon type and complete with isolating/valves. The pressure gauge shall conform to IS: 3624 and temperature gauge as per BS: 1041.

B. Water flow switch shall be vane actuator type or differential pressure type, with adjustable actuation set point. The level switch shall be ball float operated magnetic type complete with cage. The switch case shall be weather proof conforming to NEMA-4.

C. Apart from the thermostat, pressure switches, level switches and level indicators specified in this tender document, the local instruments shall also be furnished as a part of the system as shown in drawings enclosed and as per functional requirement.

D. The range of controls and instruments should be such that the operating ranges are preferably in the mid scale. The accuracy should not be less than + 1% of full scale deflection. The repeatability of readings shall be + 1%. The differential in controls should be such that the equipment is able to operate at desired settings or maintain desired condition.

E. The scale of pressure indicators for refrigerants units will be in kg/cm2. Saturation temperature of the refrigerant in use, at the corresponding

pressure should also be indicated in the scale. The suction and oil gauge shall be compound gauge. The scale of pressure indicator for pumps will be in meter. The temperature indicator's scale will be in ℃. The range should be such that even when the equipment is idle and the temperature of the medium is at such variance, the indicator will not be damaged.

F. All instruments should be such selected and installed that they are easily readable from the floor.

7.00.00 SPECIAL TOOLS

The supplier shall furnish a complete set of all special tools, wrenches etc. with necessary toolboxes as required for erection, operation & maintenance, overhaul or complete replacement of any equipment supplied under this specification. The supplier shall enclose a list of such tools recommended by them.

8.00.00 SPARE PARTS

8.01.00 The supplier shall furnish and quote the Mandatory spare parts for the complete Air Conditioning System Equipment as per the list attached in the other part of the specification.

9.00.00 TESTING AND INSPECITON AT MANUFACTURER'S WORKS

9.01.00 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of the applicable codes.

9.02.00 Following tests shall be carried out during and after completion of different component parts as applicable and in accordance with the requirements of the applicable codes.

9.03.00 Material analysis and testing shall be carried out.

9.04.00 Hydraulic test for pressure parts including piping of VAM & its components, pumps, compressors & its components, vessels etc.

9.05.00 Dynamic balancing of all the rotating parts is to be done.

9.06.00 Performance test of Vapor Absorption Chiller, pump, compressors, condenser, cooling towers and air handling units shall be done as per code procedure.

9.07.00 Tests on motors as per Indian Standard IS-325 and IS-4029.

9.08.00 Other tests, as necessary and recommended by the manufacturer.

Test certificates and reports shall be made available to the Purchaser / Engineer on the above tests, for approval and before despatch of equipment.

The representatives of Purchaser / Engineer shall be given full access to all tests. The Tenderer shall inform the Purchaser within 21 days prior to important shop tests so that if the Purchaser / Engineer so desires, their representatives can witness the tests.

Cost of conducting all shop tests shall be borne by the supplier.

10.00.00 **FIELD TEST**

10.01.00 Overall performance of the air conditioning system with peak summer and monsoon outside conditions as well as individual equipment shall be tested after complete installation at site. Duration of such test shall be 72 hours. This test shall be carried out to determine whether the plant meets the performance requirements specified here in and shall include measurements of all parameters under various outside conditions and establishment of correct supply of equipment. All testing and calibrating instruments required for this purpose shall be supplied by the contractor.

10.02.00 Inspection and testing of duct work

All component and duct work supplied shall be subjected to inspection and testing as per relevant codes and standard.

10.03.00 All ductwork shall be carefully examined to determine their performance with the specification with respect of dimensions, materials, marking, leakage, workmanship and other requirement.

10.04.00 The contractor shall give assistance for all site tests of the equipment according to prescribed procedure laid down by the Manufacturer / Engineer.

11.00.00 **PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND RECORDS**

11.01.00 The Tenderer shall have to guarantee the performance of individual equipment. The Tenderer shall also guarantee maintenance of the inside conditions as indicated under “design criteria”.

11.02.00 **Rectification of Deficient Performance**

If the shop / site performance tests indicate the failure of the guaranteed performance of the equipment concerned, the tenderer will be given sometime to make good the deficiency at his own cost by incorporating the necessary modification, alteration and replacement.

11.03.00 **Test Records**

The certificates and records of the above mentioned tests should be submitted to the Purchaser for approval. The manufacturer shall maintain records of all tests required in the specification for at least 5 years. A list of records shall be submitted to the Purchaser on completion of the job. The Purchaser shall be able to obtain certified copies of such records at any time.

12.00.00 **SPECIAL CLEANING, PROTECTION & PAINTING**

12.01.00 Internal surface of all parts shall be cleaned to remove loose scale and dirt. The external surface of the motor and end shield shall be sand blasted to remove all rust, scale etc. All sharp edge shall also be removed. Welded rods, studs and other foreign objects shall be removed prior to final assembly. Excess oil and grease shall be removed by wiping.

12.02.00 All parts shall be painted with two (2) coats of rust preventing paint. One (1) cost of final paint shall be applied over and above the rust proof paint before despatch of material.

12.03.00 All equipment shall be boxed / created or otherwise protected for shipment. Dry nitrogen desiccant and other protection shall be provided as may be necessary.

13.00.00 **DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL**

13.01.00 Beside submitting the enclosed Proposal Exhibit Sheets duly filled in, the proposal shall also include the following drawings, curves and information wherever applicable.

Preliminary cooling and heating load calculation is to be furnished.

13.02.00 Preliminary equipment layout drawings of the air conditioning plant room, AHU room and preliminary ducting layout drawing are to be furnished.

13.03.00 Manufacturer's catalogue and literatures incorporating outline and sectional drawings and ducting data for the following equipment:

Screw Compressor
Water-cooled Condensers
Chiller
Air Handling Unit (Fan, cooling coil & filter)
Drive motors for various equipment as applicable
Condenser cooling & chilled water pumps
Cooling tower
Non chemical water treatment

Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct able Split Air-conditioner
Fan Coil Unit
Motor
Direct Digital Controller

13.04.00 Manufacturer's selection chart for the following equipment:

Water-cooled Screw Chiller
AHU
Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Unit
Pump
Cooling Tower
Fan
Fan Coil Unit

13.05.00 Manufacturer's catalogues and literatures on air conditioning system, instruments and controls.

13.06.00 Sectional drawings for air diffusers and grilles, as applicable.

13.07.00 Manufacturer's data sheets for filters and refrigerant.

13.08.00 Drive list

13.09.00 A detailed experience list about supply for system of similar type for similar application mentioning in each case the salient technical parameters, date of commissioning and name of customers.

13.10.00 A comprehensive write-up and / or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.

13.11.00 Any other relevant data and particulars.

14.00.00 POST AWARD DOCUMENTS, DATA TO BE FURNISHED

14.01.00 Description of the system offered.

14.02.00 Sizing calculations for all equipment and accessories which include cooling and heating load calculations, system pressure drop calculations, duct sizing calculations, pump capacity calculation, calculations for AHUs/FCUs and fresh air fans.

14.03.00 Particulars of drawings, data, instruction manual and Drive List.

14.03.01 Equipment layout drawing for

Packaged Screw Chiller
Air conditioning plant room
Air handling unit room
Cooling Tower
Pump
Expansion Tank
Make-up Water Tank
Water-cooled precision air conditioner

Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Unit
Fan Coil Unit

14.03.02 Schematic flow and instrumentation diagram of the complete system indicating the limits of supply and erection.

14.03.03 Ducting layout drawing showing the details of duct sizes, duct joints, duct insulation, duct supports, diffusers, grilles, dampers etc.

14.03.04 Layout drawings showing the route of Steam piping, refrigerant piping and cooling water piping with details of insulation hangers, supports etc.

14.03.05 Outline drawings incorporating all principal dimensions, civil foundation drawings and weight etc. and also sectional drawings incorporating data of material of construction wherever applicable for following equipments:

Water-cooled Screw Chilling Unit
Air handling unit
Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Air conditioner
Drive motor for above equipment as applicable
Cooling tower
Expansion tank
Make-up Water Tank
Fan coil unit

14.03.06 Drawings and data sheets of each of Equipment and Instruments.

14.03.07 Drawings and data sheets for air filters, refrigerant / filter drier.

14.03.08 Write up on system interlock and / or interlock block diagram.

14.03.09 Electrical schematic and wiring diagram for control panel and the system as applicable with back-up write-up.

14.03.10 Control panel / Switchgear outline drawings, bill of instruments and drawings showing construction of control panel / switchgear.

14.03.11 Reflected False Ceiling Plan indicating detail of supports/ hangers, grids, fixing detail of Grilles and diffusers and lighting fixtures etc.

14.03.12 Fixing/ application detail of under deck insulation indicating type and thickness and weight of insulation.

14.03.13 Other drawings and data.

14.03.14 Material test certificates.

14.03.15 Shop test reports and certificates.

14.03.16 0peration, maintenance and overhauling manuals shall be provided as per following specification.

OPERATION AND MAINTENANCE MANUAL

The successful tenderer, shall prepare, during the project execution stage a manual giving details of operation and maintenance instructions. The manual will be comprehensive manual and will be provided by the Engineer. The manual shall cover but not limited to the following aspects:

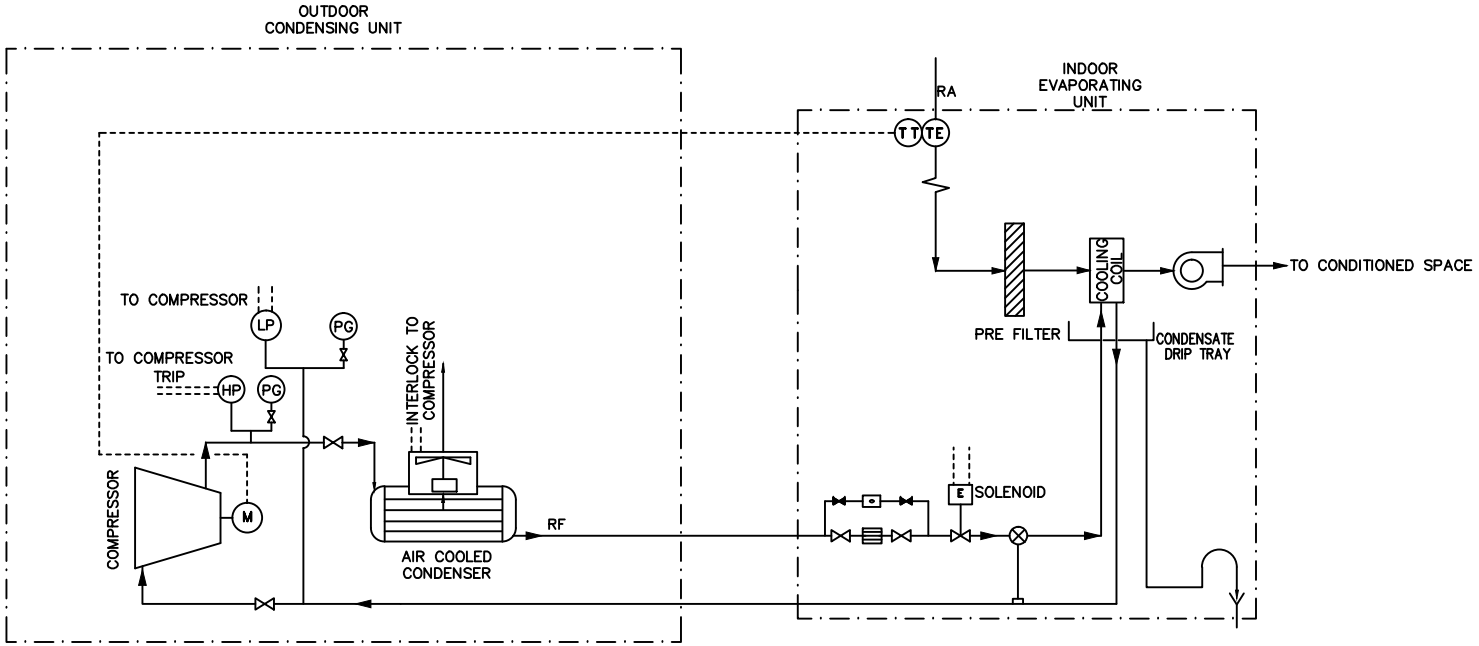
i) Equipment description with design particulars.
ii) Installation and Maintenance Instruction including preventive maintenance requirements.
iii) Instruction for pre-commissioning check-up, operation.
iv) Trouble shooting.
v) Spare Parts list.
vi) Lubricant and lubrication schedule
vii) Control logic and inter connection and calibration of controls.
viii) System description
ix) Necessary drawings, illustration
x) List of manufacturer's name and catalogues
xi) Safety instructions.

The manual shall be securely bound in hard back durable folder with proper indexing and separators.

15.00.00 List of Drawings

Sl. No.	Drawing No.	Description
01.	13A06-003-DWG-VA-001	Schematic Diagram of Package Screw Chiller Unit
02.	13A06-003-DWG-VA-002	Schematic Diagram of Water Cooled Precision Air Conditioner
03.	13A06-003-DWG-VA-003	Schematic Diagram for Common Chilled Water Type Air

		Conditioning System of Power House and Service Building
04.	13A06-003-DWG-VA-004	Schematic Diagram of Air Cooled Precision Air Conditioner
05.	13A06-003-DWG-VA-003	Schematic Diagram of Air Cooled Split AC Unit



LEGEND	
SYMBOL	DESCRIPTION
	GATE VALVE
	STRAINER DRYER
E	SOLENOID VALVE
PG	PRESSURE GAUGE
LP	LOW PRESSURE SWITCH
HP	HIGH PRESSURE SWITCH
	MOISTURE INDICATOR
M	MOTOR
	OPEN/DRY FUNNEL
	ELECTRICAL LINE
	AIR SUPPLY / RETURN LINE
	FILTER
TE	TEMPERATURE ELEMENT
TT	TEMPERATURE TRANSMITTER
	THERMOSTATIC EXPANSION VALVE

FOR TENDER PURPOSE ONLY

TELANGANA STATE POWER GENERATION CORPORATION LIMITED
HYDERABAD - TELANGANA - INDIA

REVIEWED										
			KB	AD	AG	SD	FOR SPECIFICATION		A	15.07.13
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

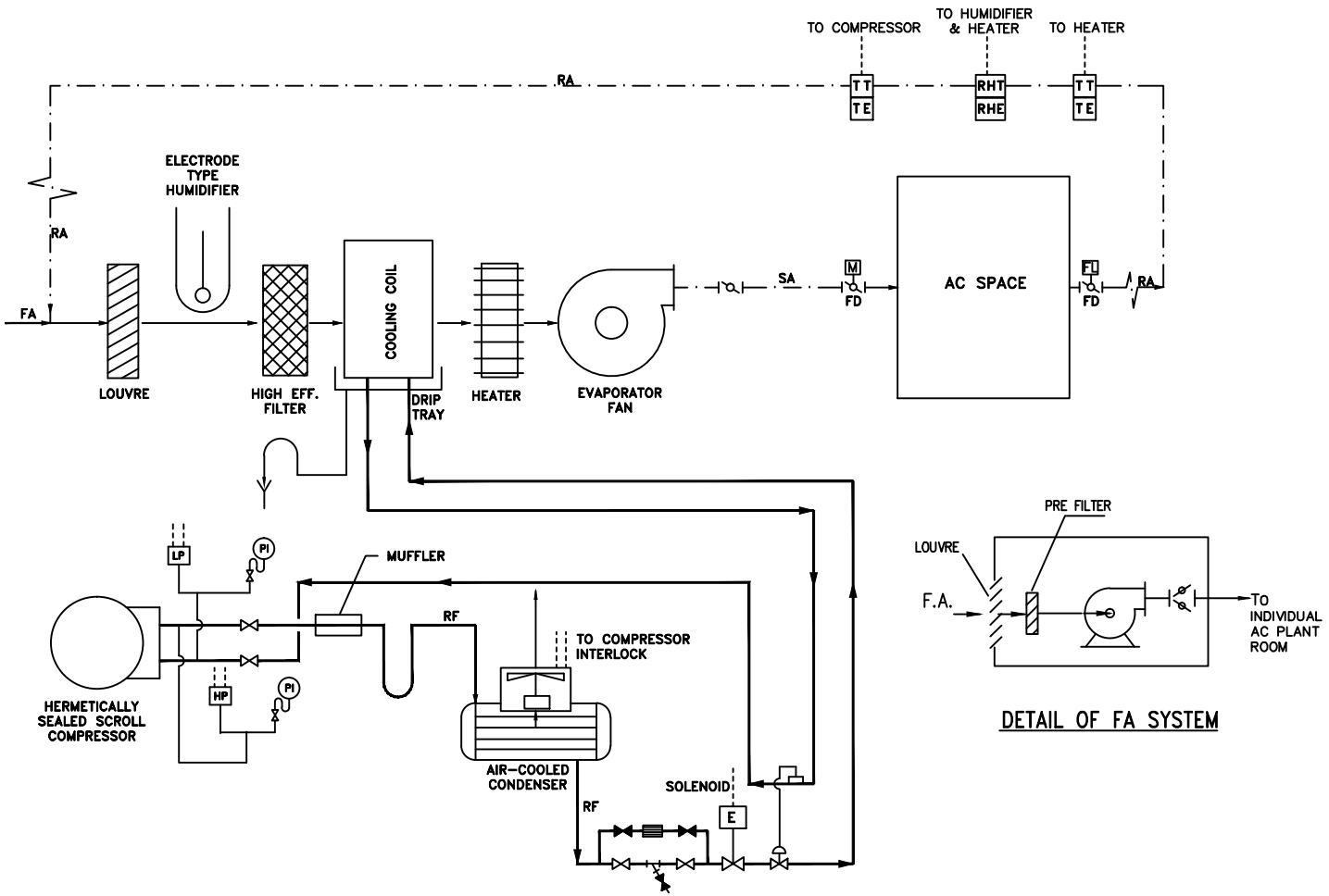
TITLE: SCHEME DIAGRAM OF AIR COOLED SPLIT AC UNIT

PROJECT: KOTHAGUDEM THERMAL POWER STATION
STAGE-VII, UNIT # 12 (1X800MW)
KOTHAGUDEM, TELANGANA, INDIA

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA . MUMBAI . CHENNAI . NEW DELHI

JOB NO. 13A06 | SCALE : NONE

DWG. NO. 13A06-003-DWG-VA-005 | REV. A



SCHEMATIC DIAGRAM OF AIR COOLED PRECISION AIR-CONDITIONER

DETAIL OF FA SYSTEM

LEGEND	
SYMBOL	DESCRIPTION
	GATE VALVE
	GATE VALVE (NORMALLY CLOSED)
	ELECTRONIC EXPANSION VALVE
TI	TEMPERATURE TEST POINT
PI	PRESSURE TEST POINT
LP	LOW PRESSURE SWITCH
HP	HIGH PRESSURE SWITCH
	Y-STRAINER
	FILTER DRIER
	ELECTRICAL LINE
	DAMPER
	FILTER
	INDUCED FAN
	AIR SUPPLY / RETURN LINE
M FD	MOTORISED FIRE DAMPER
FL FD	FUSIBLE LINK TYPE FIRE DAMPER
TT	TEMPERATURE TRANSMITTER
TE	TEMPERATURE ELEMENT
RHT	RELATIVE HUMIDITY TRANSMITTER
RHE	RELATIVE HUMIDITY ELEMENT

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TELANGANA STATE POWER GENERATION CORPORATION LIMITED
HYDERABAD - TELANGANA - INDIA

REVIEWED										
			KB	AD	AG	SD	FOR SPECIFICATION		A	15.07.13
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

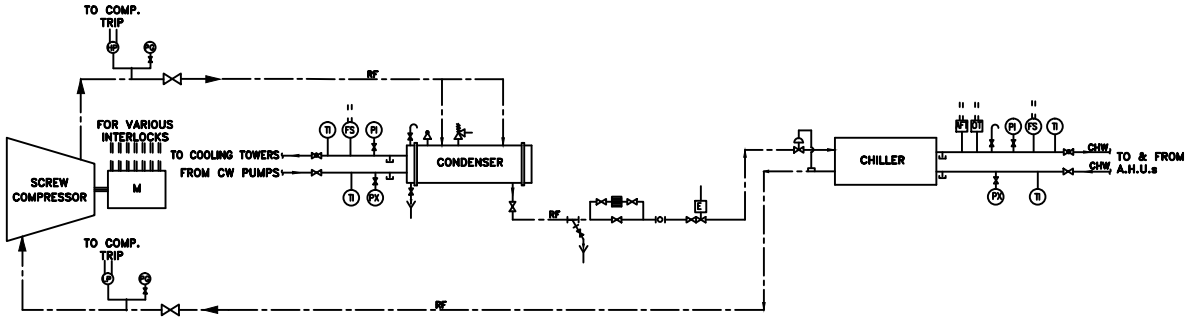
TITLE: SCHEMATIC DIAGRAM OF AIR COOLED PRECISION AIR-CONDITIONER

PROJECT: KOTHAGUDEM THERMAL POWER STATION STAGE-VII, UNIT # 12 (1X800MW) KOTHAGUDEM, TELANGANA, INDIA

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA . MUMBAI . CHENNAI . NEW DELHI

JOB NO. 13A06 | SCALE : NONE

DWG. NO. 13A06-003-DWG-VA-004 | REV. A



TYPICAL SCHEME FOR PACKAGED SCREW CHILLER UNIT

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	NORMALLY CLOSED GATE VALVE	M	MOTOR
	GATE VALVE	OT	OPERATING THERMOSTAT
	SAFETY VALVE		AIR VENT
	CHECK VALVE		OPEN/DRY FUNNEL FOR DRAIN
	GLOBE VALVE		FUSIBLE PLUG
	THERMOSTATIC EXPANSION VALVE		ELECTRICAL LINE
	SOLENOID VALVE	RF	REFRIGERANT LINE
TI	TEMPERATURE INDICATOR	CHW	CHILLED WATER LINE
PI	PRESSURE INDICATOR	CW	CONDENSER COOLING WATER LINE
PX	PRESSURE TEST POINT	AFT	ANTIFREEZE THERMOSTAT
LP	LOW PRESSURE SWITCH		SCREWED PLUG
HP	HIGH PRESSURE SWITCH	FS	FLOW SWITCH
	MOISTURE INDICATOR		Y-STRAINER
			FILTER DRIER

FOR TENDER PURPOSE ONLY

TELANGANA STATE POWER GENERATION CORPORATION LIMITED
HYDERABAD - TELANGANA - INDIA

REVIEWED										
			KB	AD	AG	SD	FOR SPECIFICATION		A	15.07.13
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

TITLE: SCHEMATIC DIAGRAM OF PACKAGED SCREW CHILLER UNIT

PROJECT: KOTHAGUDEM THERMAL POWER STATION STAGE-VII, UNIT # 12 (1X800MW) KOTHAGUDEM, TELANGANA, INDIA

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA . MUMBAI . CHENNAI . NEW DELHI

JOB NO. 13A06 | SCALE : NONE

DWG. NO. 13A06-003-DWG-VA-001 | REV. A

SECTION: I

SUB-SECTION: C 2B

CUSTOMER SPECIFICATION-PROJECT SPECIFIC GENERAL REQUIREMENT

VOLUME : X

SECTION - I

PERFORMANCE GUARANTEES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PERFORMANCE GUARANTEES, PERFORMANCE/ ACCEPTANCE TESTS & LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE
2.00.00	START-UP, INITIAL OPERATION, RELIABILITY RUN AND PERFORMANCE TESTS
3.00.00	SCHEDULE OF GUARANTEES WHICH ATTRACT LIQUIDATED DAMAGES [CATEGORY-A]
4.00.00	SCHEDULE OF GUARANTEES WHICH DO NOT ATTRACT LIQUIDATED DAMAGES [CATEGORY-B]

VOLUME : X

SECTION-I

PERFORMANCE GUARANTEES

1.00.00 **PERFORMANCE GUARANTEES, PERFORMANCE/ACCEPTANCE TESTS & LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE**

1.01.00 The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in this specification. The guarantees are categorised as:

a) Those which attract liquidated damages, as listed below (Category-"A"). The Bidder shall furnish signed declarations in the manner prescribed in the bid proposal schedules for these guarantees.

b) Those which do not attract liquidated damages, as listed below (Category-"B"). This guarantee list indicated in this section is not exhaustive and the Owner reserves the right to call upon the Bidder to demonstrate any parameter, operation, etc. of any equipment as specified and as required to meet the duty conditions.

1.02.00 The guaranteed parameters shall be without any tolerance values. The Bidder shall demonstrate all the guarantees covered in various volumes and sections of this specification during Performance/Acceptance test. In case during tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modification to make the equipment/system comply with guaranteed requirements. However, if the Contractor is not able to demonstrate the guarantees, even after the modifications within ninety (90) days of notification by the Owner, the Owner will at his discretion :

i. reject the equipment and recover the payment already made or accept the equipment only after levying liquidated damages as identified in this section for those guarantees which are covered under category "A".

OR

ii. reject the equipment and recover the payment already made or accept the equipment only after assessing and deducting from the contract price an amount equivalent to the deficiency of the equipment/system as assessed by the Owner, for those guarantees which are covered under Category-B.

1.03.00 All guaranteed parameters shall necessarily be quoted by the Bidder based on the established proven results obtained from similar units in successful operation. Evidence for this shall necessarily include the test codes used, acceptance test results, accuracies of various instruments used for the performance test, details of tolerances, if allowed, etc. While quoting the guaranteed parameters, the Bidder shall keep in view the requirements

specified in the specification especially regarding the reliability, operability and maintainability of the equipment proposed. The Owner reserves the right to evaluate the parameters quoted by the Bidder based on his experience and published material available.

1.04.00 The liquidated damages shall be calculated prorata for the fractional parts of the unit unless stated otherwise.

1.05.00 The turbine generator, boiler, auxiliaries, and all other plant equipment and system shall perform continuously without the noise level (individual or collectively) exceeding the values specified in respective equipment specification over the entire range of output and operating frequencies.

1.06.00 **Performance/Acceptance Tests**

1.06.01 The performance/acceptance tests for various equipment and systems shall be carried out as specified under the respective equipment specifications and those specified below shall be specifically applicable. All the guarantees shall be tested together as far as practicable.

1.06.02 In case of systems with stand-by equipment the liquidated damages for non-performance will be levied for normal operating number of equipment only. However, for this purpose all the equipment including standby equipment shall be tested and average values arrived at.

1.06.03 For instrument inaccuracies during PG Test, refer subsequent clauses of this section.

1.06.04 For Total Auxiliary Power Consumption, the transformers listed under the respective clauses, shall be taken together for purposes of guarantee and not individually.

2.00.00 **START-UP, INITIAL OPERATION, RELIABILITY RUN AND PERFORMANCE TESTS**

For the purpose of Taking over of the Plant, the following activities shall have to be completed successfully.

i) Mechanical Completion
ii) Preliminary Operation
iii) Initial Operation
iv) Reliability Operation
v) Trial Operation
vi) Performance Guarantee Tests

2.01.00 **Mechanical Completion**

(a) Mechanical completion is defined as the state of readiness of works and completeness of Field Quality checks under the scope of contract to undergo the pre-commissioning checks, followed immediately thereafter by commissioning including preliminary operation, initial operation, reliability operation, performance tests including unit characteristics tests for functional or operational occupation of the

works.

(b) Mechanical completion shall be deemed to occur when the contract erection/installation/construction and Field Quality check works are completed as per specifications for all equipment / systems including standby. It also include but not limited to the following:

(i) all installation/erection and Field Quality checks duly carried out and individual protocol viz. erection, FQA (Field Quality Assurance) and commissioning protocol to be signed.

(ii) all defects/deficiencies notified by the Purchaser during installation/erection rectified to the satisfaction of Purchaser which, in the opinion of the Purchaser, will not affect the safe operability and maintainability of the works, and

(iii) the contract works, in the opinion of Purchaser, subject to sub-clause (ii) above, being fit, sound, safe and operable for undertaking the pre-commissioning checks, preliminary operation, initial operation, reliability operation and performance tests including unit characteristics tests followed by subsequent commercial operation without interruption for reason of defect/deficiency or unfulfilled obligations of the Contractor in the erection/installation work.

2.02.00 **Specific Requirements of Mechanical Completion**

(a) Mechanical completion in different disciplines shall be determined based on the following characteristics, signifying the readiness of the works/plants and systems for undertaking the pre-commissioning checks and subsequent preliminary operation, initial operation, reliability operation and performance tests including unit characteristics tests as applicable to the contract works:

(i) All plant construction/installation in various disciplines, as detailed under (b) below and as applicable to the contract are completed including aesthetic and workmanship and safety aspects, with all installation/construction checks as per specification, relevant codes, standards and practices ensuring conformity to contract and meeting any applicable statutory requirements.

(ii) All contractual obligations up to the stage of completion of construction / installation are fulfilled to the satisfaction of the Purchaser.

(b) All contract works or otherwise ready to be taken into service, or for functional or operational occupation save pre-commissioning/ commissioning checks, preliminary operation, initial operation, reliability operation, performance tests, unit characteristics tests are to be carried out as per approved commissioning procedure submitted by the contractor including but not limited to the following:

(i) Areas inclusive of all roads, accesses, structures, housings, platforms, walkways, stairs, ladders, safe approach to equipments, safety/ protective guards, covers, hand rails and such items of work are constructed as per specification and approved for use.

(ii) Drains, sewers, waste disposal channels, vents, chutes, ducts and such works are constructed and connected to treatment and other disposal systems.

(iii) Equipment and piping in different systems/disciplines with all appurtenances, auxiliaries and accessories along with supporting structures, hangers, mounts, etc., are erected/ installed, supported, anchored, aligned, grouted and adjusted for operating conditions.

(iv) Electrical power supply, control, communication and lighting equipment along with control panels, control desks, switchgear, local starters and such accessories along with protective systems, interlocks and integral and auxiliary systems are permanently installed, aligned and adjusted, with megger, continuity and specified installation checks duly carried out.

(v) Cables are laid, routed, supported, dressed, clamped, tagged, ferruled and terminated with clamp terminals designated and all continuity and megger checks duly carried out.

(vi) Safety/relief valves are calibrated and set to operating conditions and tried out. All safety systems are installed, calibrated, checked and accepted.

(vii) Plant identification numbers, colour codes, tags, nameplates are duly mounted / painted/affixed.

(viii) All painting, lining and insulation works are completed with specified checks to the satisfaction of the Purchaser.

2.03.00 **Other Prerequisites for Mechanical Completion**

The Contractor shall also meet the following prerequisites for mechanical completion:

(a) Submit a compilation of all reports of shop tests, material tests and various stage inspection establishing total compliance to contract specification in manufacturing items of supply of contract.

(b) Submission of a certificate by the Contractor in a format agreed by the Purchaser that the contract works have been designed, selected, manufactured, furnished and installed under the full responsibility of the Contractor.

(c) All erected plants, structures, equipment and systems are maintained and preserved in sound condition and are fit and sound to undertake

pre-commissioning checks and 'tests before commercial operation' for operational and functional occupation immediately thereafter.

(d) All areas and constructed works are cleared daily upto the satisfaction of the Owner of all construction materials, temporary works, debris, rubbish water and all such impediments to render the contract works safe, sound and operable.

(e) All safety features and safety equipment are functional.

(f) Fire prevention and fire extinguishing system in all fire prone areas are to be made functional.

(g) Any specific statutory approvals pre-requisite to commissioning of the plant are duly obtained.

2.04.00 **Preliminary Operation**

Preliminary operation shall mean all activities undertaken as part of commissioning after mechanical completion upto commencement of initial operation and shall include mechanical and electrical checkouts, calibration of instruments and protection devices, commissioning of sub/supporting systems covered under the contract.

2.05.00 **Initial Operation**

Initial operation shall include all operations undertaken as part of commissioning after completion of preliminary operation upto commencement of reliability operation. It shall be the first integral operation of the complete BOP integrated with Boiler, Turbine Generator package covered under the contract and shall include first light up / initial equipment rolling, equipment stretch-out, dry-out no-load / partial load /full loads runs for mechanical / electrical tryout and gathering of operational data, calibration, setting and commissioning of controls systems; and shutdown inspection and adjustment after running trails of the plant under the contract.

During initial operation each and every activity wise commissioning protocols are to be jointly signed by the Purchaser and Contractor commissioning team.

The auto loop control tuning shall continue upto the commencement of 72 hour full load operation of trial run.

The initial operations shall include operation of unit as a whole under normal operating conditions for twenty four (24) consecutive hours at the 100% TGMCR load or twelve (12) consecutive hours for two (2) consecutive days at the 100% TGMCR load unless otherwise agreed to by the Purchaser or restricted by system load conditions. The completion of initial operation will be certified in writing by the Purchaser.

2.06.00 **Reliability Operation**

(a) After the initial operations, the plant shall be on reliability operation. During the reliability operation, the Contractor will be allowed to make

minor adjustments as may be necessary, provided that such adjustments do not interfere with or prevent the commercial use of the plant or result in significant reduction of output. The duration of the reliability operation of plant shall be spread over a period of thirty (30) days. The maximum number of interruption attributable to Contractor shall be of four (4) numbers each not exceeding four (4) hours duration. In case either the number of interruptions, attributable to the Contractor, exceeds four (4) or the duration of any of the four (4) interruptions exceeds four (4) hours the reliability test shall be repeated.

(b) For the period of reliability operation, the time of actual operation shall be counted. In case the duration of actual continuous operation of any of the above modes is discontinued for reasons, which are not due to Contractor's fault or negligence, that particular test would be deemed to have satisfied the reliability operation test. However, should the test be discontinued due to Contractor fault, the test shall be restarted for that particular case.

(c) Should any failure (other than of an entirely minor nature) due to or arising out of faulty design, materials, or workmanship (but not otherwise) occur in any item of the plant, sufficient to prevent commercial use of the plant, the reliability test period of thirty (30) days shall recommence for that item after the defect has been remedied by the manufacturer/Contractor. The onus of proving that any failure is not due to faulty design, materials and workmanship will lie with the Contractor.

(d) A 'reliability operation' report comprising observations and recordings of various parameters measured in respect of the 'reliability operation' shall be prepared and submitted to the Purchaser. This report, besides recording the details of various observations during 'reliability operation' shall also include the dates of start and finish of the reliability operation and shall be signed by the representatives of both the parties. The report shall have recordings of all details of interruptions that occurred, adjustments made and any repairs carried out during the 'reliability operation'.

Also a punch list is to be prepared during the reliability test and the defects are to be rectified by the contractor before commencement of 72 hour operation at full load during trial operation.

(e) Should any failure or interruption occur in any portion of the tests due to or arising from faulty design, materials, workmanship, omissions, incorrect erection, or inadequate instructions by the Contractor's supervisors, sufficient to prevent safe commercial use of the plant, the reliability operation test at the particular load shall be considered void and the reliability test shall recommence after the Contractor has remedied the cause of the defect.

(f) During the reliability operation all the equipments, Raw/ DM water system and sub-systems, control loops, interlocks and protection including switchyard installations will be in service and change over to standby equipments are to be done on running condition of the unit.

(g) The 'reliability operations' shall be considered successful, provided that each item of plant can meet the above requirements.

(h) Upon the completion of 'reliability operations', as soon as practicable, or at such time as may be otherwise agreed to by the parties concerned, the Contractor shall notify in writing to the Purchaser that the Plant is ready for performance tests.

2.07.00 **TRIAL OPERATION:**

1. On completion of erection of any major items along with its auxiliaries, the same shall be thoroughly inspected by the Contractor together with the TSGENCO's Engineers for correctness and completeness and acceptability for pre-commissioning tests. Though the TSGENCO's Engineers associate themselves with such inspection, the responsibility for declaration for correctness, completeness and acceptability shall rest with the Contractor and the pre-commissioning tests and inspections shall be carried out after such declaration. The pre-commissioning tests to be performed at site as well as necessary documentation and formats for the protocols to be signed during and after the tests shall be prepared by the Contractor taking into account relevant Indian/International/ Manufacturers standard as applicable and finalized by the TSGENCO sufficiently in advance through mutual discussions. On conclusion of satisfactory pre-commissioning tests of each individual equipment, the trial operation of the unit shall start consistent with parameters of the technical specifications.

2. The duration of trial operation shall be for 14 days during which period the unit shall be run from half to full load or any other load cycle mutually agreed to during which period the unit shall run at full load for 72 hours continuously. However, if required, the Purchaser and the Contractor may mutually agree for economical load operation for 48 hours continuously. Any interruption caused by the Contractor up to 24 hours will not effect the period of 14 days indicated above. In case of such interruption occurring for more than 24 hours, the above period shall be extended correspondingly. During the above trial operation the standby auxiliary equipment shall also be run for a minimum period of more than 72 hours during which period the equipment shall run at its rated capacity for a minimum period of 24 hours. Further the above trial operation shall be carried out in full fledged manner with the associated instruments and controls. The unit is deemed to be commissioned on successful completion of the above trial operation.

3. A document shall be prepared on the results of trial operation. This document besides recording of the details of the various observations during the trial run will also include the date of start and finish of the trial operation and will be signed by the representative of both the parties. The document of the trial operation shall have log sheets and all adjustments, repairs, interruptions etc., shall be recorded therein. If any major adjustment is carried out which has been changed from the initial operation value, then the reason for it is to be furnished in the

report in detail.

The Purchaser and the Contractor will observe the plant overall reliability and shall test the equipment runback, rundown, auto start of equipments, CMC function and its reliability, complete automation of the plant system etc.

4. The readiness of the unit for the trial operation shall be intimated by written notice to the TSGENCO after mutual discussions. After receipt of such notice if the trial operation could not be performed or could not be completed due to any reasons not attributable to the Contractor and if the situation continues, the Contractor shall be absolved of the responsibility for the delay and the plant shall be deemed to have been taken over by the TSGENCO at the end of 60 days after the Contractor's notifications of readiness of the same.

5. The trial operation shall be carried out in compliance with relevant manufacturer's standards and/or relevant Indian/International standards and manufacturer's operation directions before starting them.

6. Defects which are minor in nature and do not endanger the safe operation of the plant, shall not be considered as reasons for not taking over the plant by the TSGENCO. These defects shall be listed in the above mentioned documents and shall be rectified by the Contractor in accordance with the agreement made in this respect.

2.08.00 **Performance Tests**

(a) PG test notification to be given by the contractor to the purchaser after COD. The performance tests shall be conducted at site on all major systems by the Contractor. The Contractor's commissioning Engineers shall make the entire plant ready for such tests and assist the Purchaser in operation during the tests. The test shall be commenced after the 'Plant/Equipment' has attained stable operation at the end of 'reliability operation'. The date of commencement of the performance tests shall be as soon as practicable on completion of the 'reliability operation' or as may be mutually agreed upon between the Contractor and Purchaser.

Final trail operation shall be carried out for a period of seventy two (72) hours at 100% TGMCR before 'taking over'.

(b) **Independent Inspector**

The Purchaser reserves his right to appoint an independent inspector at his own cost as his representative to discuss the test programme, to approve the instrumentation, to witness the tests and to analyze the test results.

(c) The tests shall be binding on both the parties of the contract to determine compliance of the 'plant'/'equipment' with the performance

guarantees.

(d) The performance tests shall be carried out to prove the guarantees. The purpose of the performance tests is to check whether the plant meets the guaranteed performances.

(e) The performance test procedure, the instrumentation to be installed, the instrument accuracy classes, including the definition of the calculation method to be used, the areas of responsibility and the items which specifically require preparation and agreement shall be submitted by the Contractor for review and approval during detail engineering phase. The schematics identifying the guarantee test instrumentation shall be submitted along with procedure. It shall be ensured that necessary test points and spool pieces are installed during the detail-engineering phase and also identified in process and instrumentation drawings. Code of the PG test is to be fixed up during detail engineering stage. The Contractor shall furnish detail test programme during detail engineering stage.

(f) The performance test instruments shall be of precision type with instrument accuracy limits as required and defined in the applicable performance test codes such that measurement uncertainty does not exceed the values agreed to by the Contractor in the Schedule of Performance Guarantees.

(g) All test instrumentation for the performance tests as required shall be supplied by the Contractor on loan basis. All costs associated with the supply, calibration, installation and return of the test instrumentation are deemed to have been included in the contract price. The test shall be in accordance with those specified or as per agreed performance test codes. Batch calibration shall not be accepted.

(h) Any special equipment, tools and tackle required for successful completion of the performance tests shall be provided by the Contractor.

(i) It is Contractor's responsibility to co-ordinate for carrying out the performance tests. The duration of the test shall be in accordance with the agreed test codes. All other tests to prove the guarantees as indicated in the Contractor's offer shall also be conducted.

(j) The plant parameters during the performance test shall be adjusted as far as practicable to the guaranteed performance test conditions. The tests shall be conducted to provide guaranteed parameters as defined in the contract.

(k) Category-B tests are to be completed before Category-A PG test. Protocols are to be signed jointly by the Purchaser and Contractor for each Category-B test.

(l) **Reporting of Test Results**

(a) Within two weeks after the conclusion of the performance test,

the Contractor shall submit ten (10) copies of test reports to the Purchaser stating whether the plant passed or failed such test(s), accompanied by sufficient test data and calculations to demonstrate the level of performance attained with respect to each of the tested parameters.

(b) The report(s) shall include as a minimum, the following:-

(i) Scope

(ii) Various guaranteed parameters & tests as per the contract.

(iii) Codes/standards used

(iv) . Description of the test procedures

(v) Full schematic diagrams with indication of test instruments locations and identification tags of same.

(vi) Instrumentation details and calibration.

(vii) Duration of test, frequency of readings and number of test runs

(viii) Test logs and summary of test readings used for performance calculations.

(ix) Full set of correction curves.

(x) Computation of test results.

(xi) Sample calculation

(xii) Performance calculation

(xiii) Computations to prove measurement uncertainty is within acceptable limits.

(xiv) Acceptance criteria

(xv) Any other information required for conducting the test

(xvi) Conclusions of performance tests.

(m) Within fifteen (15) days of receipt of such test report(s), the Purchaser shall submit a notice to the Contractor stating either:-

(i) That Purchaser concurs with the information provided in the test report(s), or

(ii) That Purchaser disputes some or all of the information provided

in the Contractor's test report(s), the areas being disputed, and the levels of performance being disputed.

(n) If Purchaser concurs with the information in the Contractor's test report(s), the Purchaser shall, within fifteen (15) days of receipt of the test report, provide a written notice to the Contractor accepting the results of the tests.

(o) If Purchaser disputes any or all of the results contained in the Contractor's test report(s), the Contractor and Purchaser shall meet within fifteen (15) days of the receipt of the Purchaser notice at a mutually acceptable location to review and discuss the dispute.

All the category-B test results are to be computed and to be submitted along with the PG test report for detail study by the Purchaser.

2.08.00 **Notice of Tests**

The Contractor shall issue 21 days notice to the Purchaser of the date after which he will be ready to commence the tests and the Contractor shall commence the tests promptly thereafter.

2.09.00 **Delayed Tests**

(a) If the tests could be carried out but are being unduly delayed by the Contractor, the Purchaser may by notice inform the Contractor to conduct the tests within 14 days after the receipt of such notice. The Contractor shall conduct the tests on such days within that period as the Contractor may fix and of which he shall issue notice to the Purchaser.

(b) If the Contractor fails to conduct the tests within such notice period, the Purchaser may himself proceed with the tests. All tests so conducted by the Purchaser shall be at the risk and cost of the Contractor and the cost thereof shall be deducted from the contract price or charged to the Contractor. The tests shall then be deemed to have been conducted by the Contractor and the test results shall be binding on the Contractor.

(c) **Facilities for Tests on Completion**

Except where otherwise specified, the Contractor shall provide and bear costs for these items, as may be required to carry out the tests on completion.

(d) **Retesting**

If the plant fails to pass the test (which in the case of performance tests means not achieving the acceptable limits), the Purchaser may require such tests to be repeated on the same terms and conditions save that only reasonable notice of the date and time of such tests shall be required to be given by the Contractor to the Purchaser.

(e) **Disagreement as a Result of Tests**

If the Purchaser and the Contractor disagree on the interpretation of the test results, each shall give a statement of his views to other within 14 days after such disagreement arises. The statement shall be accompanied by all relevant evidence.

3.00.00 SCHEDULE OF GUARANTEES WHICH ATTRACT LIQUIDATED DAMAGES [CATEGORY-A]

Sl. No.	Plant/ System	Parameter for Performance Guarantee	Liquidated Damages
3.01.00	**Plant**		
3.01.01	Efficiency of steam generator	Efficiency of the steam generator at 100% & 80% TMCR while firing the Design coal at rated steam parameters, rated coal fineness and rated excess air. **(Refer Note-1 for estimation of weightage factor.)** Design coal shall be blended coal (50% imported coal + 50% indigenous coal).	As per Volume-I.
3.01.02	Steam generating capacity	Steam generating capacity in T/hr of steam at rated steam parameters at superheater outlet (with any combination of mills working) with the coal being fired from within the range specified.	As per Volume-I.
3.01.03	Turbine Cycle Heat rate	Turbine Cycle Heat rate in kcal/kWh under rated steam conditions, design condenser pressure with zero make up at 100% & 80% of rated load **(Refer Note-1 for estimation of weightage factor.)**	As per Volume-I.
3.01.04	Output	Continuous output (MW) of 100% TMCR at Generator terminals under rated steam conditions at Turbine Inlet (247 kg/cm^2(a), 565°C, 593°C) and CW temperature of 33°C with 0% make-up with excitation power deducted	As per Volume-I.
3.01.05	Condenser Pressure	Condenser pressure in mm Hg (abs) under VWO conditions, 3% make up, design CW temperature and CW flow.	As per Volume-I.

Sl. No.	Plant/ System	Parameter for Performance Guarantee	Liquidated Damages
3.01.06	Total Auxiliary Power Consumption	The total auxiliary power consumption for all the auxiliaries of boiler, turbine Generator and turbine cycle equipments required for continuous unit operation at 100% and 80% of rated load under rated steam conditions and at design condenser pressure with 0% make-up. **(Refer Note 1, 2, 3 & 4 for the basis of computation of Auxiliary power)**	As per Volume-I.
3.01.07	Cooling Tower Cold Water Temperature	Cooling tower cold water at 100% TMCR under rated steam conditions and at design condenser pressure.	As per Volume-I.

Note :

1. The weightage factor shall be estimated considering the following:

   a) 80% rating for 2000 hrs in a year,

   b) 100% rating for 6300 hrs in a year.

2. For computation of Auxiliary Power, output measured at Generator terminals minus sent out power measured downstream of Generator Transformer, applicable Losses (No load loss + Load loss+ auxiliary loss for coolers) for Standby Transformers, Unit Transformers and Bus duct losses shall be considered.

3. The equipment for auxiliary power consumption to be considered by the bidder shall include the equipment as per Annexure-C of Volume-I as minimum.

4. Power consumption for Fire Pumps, Sump Pumps, Elevators, EOT Cranes shall not be considered in the Auxiliary Power consumption estimate.

5. Heat Rate of TG Cycle : Maximum 1850 Kcal/kwh with Steam Turbine driven BFP.

6. Steam Generator Efficiency : Not less than 85%

7. Auxiliary Power Consumption shall be limited to 6% with Steam Turbine driven BFP and NDCT.

8. Normal Availability of the Plant : 98% (2% forced outage)

9. Plant Reliability : Minimum 95%

10. The condenser pressure measurement while conducting the guarantee tests for Cl Nos 3.01.03, 3.01.04 and 3.01.05 above shall be measured at 300 mm above the top row of condenser tubes.

4.00.00 **SCHEDULE OF GUARANTEES WHICH DO NOT ATTRACT LIQUIDATED DAMAGES FOR VARIOUS EQUIPMENT WHICH INCLUDE BUT ARE NOT LIMITED TO THE FOLLOWING [CATEGORY-B]:**

4.01.00 **Steam Generator**

4.01.01 Capacity in T/hr of steam at rated steam parameters at superheater outlet (with any combination of mills working as per Owner's discretion) and the coal being fired within range specified, corresponding to 100% BMCR at 33°C CW temperature.

4.01.02 Efficiency in percentage at 100% & 80% TMCR and 27°C ambient air temperature and 60% RH with zero make-up, condenser vacuum of 77 mm Hg(a) or better while firing the Design coal at rated steam parameters at Superheater and Reheater outlet and rated excess air and with any combination of mills working as per Owner's discretion. Design coal shall be blended coal (50% imported coal + 50% indigenous coal).

4.01.03 Air heater air-in-leakage after 3000 hrs. of operation from taking over date. To be demonstrated.

4.01.04 NOx emission

NOx emission from the unit – shall not be more than 365 ppm or 750 mg/Nm^3 (equivalent NO_2) at the ESP outlet at 6% excess oxygen.

4.01.05 Mill capacity at rated fineness.

4.01.06 Gas tightness efficiency of Guillotine dampers.

4.01.07 No fuel oil support shall be required above 30% of BMCR.

4.01.08 Performance characteristics of pumps, fans, etc. viz; capacity, head developed etc.

4.01.09 Capabilities of all drives.

4.01.10 Margins on fans. Through operation of single fan at a time.

4.01.11 Equal load sharing of pumps/fans while running in parallel shall be demonstrated.

4.01.12 Run back capabilities.

4.01.13 Ramp/sudden load change withstand capability.

4.01.14 Life of mill wear parts

4.01.15 Furnace Exit Gas Temperature

The Bidder shall demonstrate by direct measurements that the Furnace Exit Gas Temperature (FEGT) at the specified location does not exceed the

specified maximum temperature of BMCR. The test equipment to be used for this demonstration shall be latest, state of the art, to the approval of Owner.

4.01.16 Flue Gas Temperature

The Bidder shall also demonstrate that the flue gas temperature at the entry and exit of various boiler heating surfaces and also the variation across the cross section perpendicular to gas flow do not exceed the values considered for the pressure parts design.

4.01.17 Steam Temperature Imbalance

The Bidder shall guarantee and demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10°C.

4.01.18 SH/RH Attemperation System

The Bidder shall guarantee and demonstrate that the spray water flow to SH attemperation system does not exceed the value considered for design (to be indicated in the bid) while maintaining the rated SH outlet steam temperature at BMCR. The Bidder shall also guarantee and demonstrate that the RH temperature is maintained at the rated value without any spray water requirement, for the secondary attemperation system, at all loads for which the specified RH steam temperature is required to be maintained at the rated value.

4.02.00 **Electrostatic Precipitator**

4.02.01 Pressure drop across the electrostatic precipitator.

4.02.02 Collection efficiency and outlet dust concentration shall be as per cl. no. 3.01.00 of Section-II in Volume-II-B.

4.03.00 **Turbine Generator**

4.03.01 Turbine Generator-Set Capability

The steam turbine generator unit shall be capable of delivering continuously at generator terminals the output as indicated by the Bidder in the following heat balances detailed out elsewhere with equipment specification submitted alongwith the bid.

a) Output corresponding to top HP heaters out of operation.

b) Output corresponding to all HP heaters out of operation.

c) Output corresponding to VWO flow, at rated steam conditions with condenser CW temperature 33°C & condenser of vacuum 77 mm HgA or better with 0% make-up.

d) Output corresponding to overpressure operation of the boiler-turbine-generator set, at rated main steam and hot reheat steam

temperature with condenser CW temperature corresponding to Condenser vacuum of 77 mm HgA or better with zero percent make-up.

4.03.02 Operating Frequency Range

As per the stipulations of Cl. No. 7.06.00 Vol. II-C, Section-I.

4.03.03 Constant Pressure and Sliding Pressure Operation

The constant pressure operation and sliding pressure operation from 30% turbine MCR to VWO condition of the unit in conjunction with the steam generator, HP-LP bypass system and instrumentation & control system shall be demonstrated.

In sliding pressure mode of operation, during quick load increase the idle control valve (s) must respond rapidly to pick up 20% of operating load, so that immediate increase of boiler pressure is not required. The load response capability shall be demonstrated in steps of 5 %.

Change-over from constant pressure mode to sliding pressure mode and vice-versa shall also be demonstrated.

4.03.04 Start-up, Loading, Unloading and Shutdown Capabilities

Start-up, loading, unloading and shutdown characteristics and startup time and loading capabilities for the steam turbine generator and steam generator both operating as a unit for cold start conditions (greater than 36 hours shutdown), warm start conditions (between 8 and 36 hours shutdown) and hot start conditions (less than 8 hours shutdown) under constant pressure and variable pressure mode and suitability for cyclic operation as indicated by the Bidder in the offer and accepted by the Owner shall be demonstrated ensuring the parameters of vibration, differential expansion, etc.

4.03.05 Vacuum Pulling time

Vacuum pulling time from condenser at atmospheric pressure to rated vacuum compatible to start Steam Turbine

4.03.06 Sudden Total Loss of External Load

On occasions, the steam turbine generator system may experience sudden total loss of all external load. Under these conditions, the steam turbine generator unit shall not trip on overspeed but shall continue in operation under the control of its speed governor to supply power for the plant auxiliary load station transformers, while staying within the prescribed permissible limits of steam metal temperature mismatch, exhaust hood temperature, absolute and differential expansion, vibration and eccentricity acceptable to the Owner.

4.03.07 Capacity with Reduced Hydrogen Pressure

Generator shall be capable of operating at reduced capacity at reduced generator hydrogen pressure in accordance with values furnished by the Bidder in his proposal and accepted by the Owner.

4.03.08 HP/LP Bypass Capabilities

i. HP/LP bypass capacity and capabilities under various modes of operation shall be demonstrated.

ii. Condenser performance with HP-LP Bypass operating at rated conditions.

4.03.09 Lube Oil Purification System - Capacity and Purity

Lube oil purification system capacity and the purity of purified oil at the outlet of the centrifuge and the outlet of the polishing filter, shall be demonstrated. If purity check is not possible at site, this shall be carried out at Vendor's works.

4.03.10 Extraction and CRH NRVs

Operation of the valves under turbine trip and high water level in the heaters, shall be demonstrated.

4.03.11 The performance of the condenser, i.e., the back pressure achieved at design CW flow and inlet temp. and cleanliness factors, VWO heat load shall be demonstrated.

4.03.12 Temp. of condensate at outlet of condenser shall not be less than saturation temp. corresponding to the condenser pressure at all loads.

4.03.13 Oxygen content in condensate at hot-well outlet shall not exceed the limit prescribed by HEI over the entire load range and shall be determined according to an internationally approved codes/standard.

4.03.14 When one half of the condenser is isolated, condenser capability shall be demonstrated to take at least 60% T.G. load under TMCR conditions.

4.04.00 **Deaerator**

4.04.01 The dissolved oxygen content in feed-water measured at deaerator outlet shall not exceed 0.005 cc/litre at all loads from no load to VWO condition with 3% cycle make-up with normal pressure and overpressure with incoming condensate presumed to be saturated with oxygen (without any chemical dosing).

4.04.02 Free carbon dioxide in deaerator effluent shall be non-traceable at all loads from zero to VWO with 3% cycle make-up with normal pressure according to ASTM standards.

4.05.00 **Power Cycle Pumps**

Performance of each pump (flow, head, vibration, noise, parallel operation) to be demonstrated.

4.06.00 **Automatic On Line Turbine Testing (ATT) System**

Demonstrated without disturbing normal operation.

4.07.00 **Coal Handling Plant**

Refer Cl. No. 10.00.00 in Volume-IV-A.

4.08.00 **Water Treatment System**

Performance Guarantee of Chemical Feed System shall be in accordance with Cl. No. 8.04.00 in Section-IV, Volume-II-B of the EPC Bid Specification.

Performance Guarantee of Condensate Polishing System shall be in accordance with Cl. No. 8.04.00 in Section-VI, Volume-II-C of the EPC Bid Specification.

Performance Guarantee of River Water Pre-Treatment System shall be in accordance with Cl. No. 8.04.00 in Section-I, Volume-III-C of the EPC Bid Specification.

Performance Guarantee of Demineralisation System shall be in accordance with Cl. No. 8.04.00 in Section-II, Volume-III-C of the EPC Bid Specification.

Performance Guarantee of Circulating Water Treatment System shall be in accordance with Cl. No. 8.04.00 in Section-III, Volume-III-C of the EPC Bid Specification.

Performance Guarantee of Waste Water Treatment System shall be in accordance with Cl. No. 8.04.00 in Section-IV, Volume-III-C of the EPC Bid Specification.

4.09.00 **Instrumentation and Control**

The Bidder shall demonstrate that the Instrumentation and Control system meets all the functional/performance requirements, specified in technical specifications.

4.10.00 **Noise Level**

The Bidder shall demonstrate Noise Level of various plants/equipments/systems as per Clause no. 17.02.00 in Section-IV of Volume-II-A.

4.11.00 **Air Conditioning & Ventilation system**

The rating and performance figures of the AC & Ventilation system & equipment as indicated in the respective technical specification shall be guaranteed by the Bidder. In the event of any deficiencies in meeting the guarantees as indicated in the technical specification after conducting the performance test, the bidder shall put all his efforts to rectify the deficiencies or will replace the equipment / accessories to achieve the specified performance parameters within a reasonable time.

VOLUME : IIA

SECTION-VII

QUALITY ASSURANCE REQUIREMENTS

CONTENT

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VOLUME : IIA

SECTION-VII

QUALITY ASSURANCE REQUIREMENTS

1.00.00 **QUALITY ASSURANCE PROGRAMME**

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Contractor's works or at his Sub-contractor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Contractor shall generally cover the following :

a) His organisation structure for the management and implementation of the proposed quality assurance programme.

b) Documentation control system.

c) Qualification data for Bidder's key personnel.

d) The procedure for purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

f) Control of non-conforming items and system for corrective actions.

g) Inspection and test procedure both for manufacture and all site related works.

h) Control of calibration and testing of measuring and testing equipments.

i) System for quality audit.

j) System for indication and appraisal of inspection status.

k) System for authorising release of manufactured product to the Owner.

l) System for handling storage and delivery.

m) System for maintenance of records.

n) 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 format enclosed at Annexure-I to this section for Owners approval

o) Internal standards, if referred in the quality plans shall generally be compatible with National / International standards and shall be mentioned in the quality plans. Alternatively bidder shall furnish extracts of the internal standards detailing out acceptance norm for the product / material.

2.00.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Contractor for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Contractor's responsibility to draw up and implement such programme duly approved by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Authorised representative for approval. Schedule of finalisation of such quality plans will be finalised before award.

Contractor shall furnish list of Manufacturing Quality Plans of major equipments indicating proposed inspection catagorisation indicating items that will be offered for Owner’s inspection etc and the Field Quality Plans

2.02.00 Manufacturing Quality Plan for all the major equipment will detail out their respective important components, their in-process various tests/inspection & final inspection / tests, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organization. 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 are to be comprehensibly documented by Contractor.

Manufacturing Quality Plan for all major equipments/ items will be approved by owner. In these approved quality plans, Owner / Authorised representative shall identify customer hold points (CHP), test / checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner / Authorised representative in writing. Inspection/ Test reports are to be submitted to owner as specified in final approved Manufacturing Quality Plans.

2.03.00 Field Quality Plans / Procedures for all field activities shall be submitted to

owner for review / approval. These Quality Plans / procedures will detail out, for all equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control organisation, during various stages of site activities from receipt of materials/ equipment at site.

2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, Owner/Authorised representative shall identify customer hold points (CHP), test/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work will not proceed without consent of Owner/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and major deviations in the form of Non Conformity Report shall be referred to Owner/Authorised representative for approval and dispositioning.

2.05.00 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Engineer/ Authorised representative for “CHP” and “W” points marked in quality plans , and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC). For items which is not under owner’s inspection the contractor shall apply for despatch clearance (MDCC) from owner by submitting their internal inspection reports and quality records

2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet serial numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.07.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

2.08.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section - IX (latest edition) or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Contractor's/ Sub-Contractor's works or at site shall be qualified as per ASME Section-IX (latest edition) or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner / his authorised representative or owner approved Third Party Inspection Agency(TPIA). Previously qualified WPS & PQR shall be acceptable if witnessed by owner’s approved TPIA.

For welding of pressure parts and high pressure piping coming under IBR purview, the requirements of IBR shall also be complied with.

2.09.00 All non-destructive examination (NDT) shall be carried out in accordance with LIST OF STANDARDS FOR REFERENCE as given below in this section.

The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT for the list major equipments / items identified for owner's inspection shall be properly recorded and submitted for review and approval. Other items not covered under owner's inspection, contractor shall review and approve the NDT results and such reports shall be submitted to owner in the final documentation of the items / equipments

2.10.00 All the sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Contractor and finalised with the Owner shall be subject to Owner's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor.

2.11.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Contractor and finalised with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed.

Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-vendor's quality management and control activities. The Contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/approval of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Contractor in earning satisfactory performance of equipment as per specification.

2.12.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.13.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner.

2.14.00 For quality assurance of all civil works refer to the specifications for civil works.

3.00.00 **QUALITY ASSURANCE DOCUMENTS**

3.01.00 The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms / CDs of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

a) Material mill test reports on components as specified by the specification.

b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

c) Non-destructive examination results /reports including radiography interpretation reports.

d) Factory tests results for testing required as per applicable codes and standards referred in the specification.

e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.

f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

g) Stress relief time temperature charts.

h) Inspection reports duly signed by QA personnel of the Owner and Contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded :

i) When some important repair work is involved to make the job acceptable.

ii) The repair work remains part of the accepted product quality.

i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 INSPECTION, TESTING AND INSPECTION CERTIFICATES

4.01.00 The Owner’s Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner’s Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner’s Engineer/ Authorized Inspector twenty one (21) days written notice for “CHP” / “W” points of any material being ready for testing by owner’ engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/ Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection. If owner’s Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

no case proceed with the test without owner or his authorized inspectors, unless the witnessing is officially waived and advised Contactor to proceed with the test. Contractor shall forthwith forward duly certified completed test report and a product quality certificate in six (6) copies to owner upon completion of such test.

4.03.00 The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract / QAP or other approved quality documents. 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 confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract / QAP or other approved quality documents.

4.04.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests excluding the test completion date subject to submission of all certified documents related to the test, If the tests are not witnessed by the Engineer/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the owner’s Engineer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract / QAP or other approved quality documents.

4.05.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the owner’s Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contract / QAP or other approved quality documents. Contractor and shall give facilities to the owner’s Engineer/ Inspector or to his authorised representative to accomplish testing.

4.06.00 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating proposed schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

LIST OF STANDARDS FOR REFERENCE

a) International Standards Organisation (ISO).

b) International Electro-technical Commission (IEC).

c) American Society of Mechanical Engineers(ASME)

d) American National Standards Institute (ANSI).

e) American Society for Testing and Materials (ASTM).

f) American Institute of Steel Construction (AISC).

g) American Welding Society (AWS).

h) Architecture Institute of Japan (AIJ).

i) National Fire Protection Association (NFPA).

j) National Electrical Manufacturer's Association (NEMA).

k) Japanese Electro-technical Committee (JEC).

l) Institute of Electrical and Electronics Engineers (IEEE).

m) Federal Occupational Safety and Health Regulations (OSHA).

n) Instrument Society of America (ISA).

o) National Electric Code (NEC).

p) Heat Exchanger Institute (HEI).

q) Tubular Exchanger Manufacturer's Association (TEMA).

r) Hydraulic Institute (HIS).

s) International Electro-Technical Commission Publications.

t) Power Test Code for Steam Turbines (PTC).

u) Applicable German Standards (DIN).

v) Applicable British Standards (BS).

w) Applicable Japanese Standards (JIS).

x) Electric Power Research Institute (EPRI).

y) Standards of Manufacturer's Standardization Society (MSS)

z) Bureau of Indian Standards Institution (BIS).

aa) Indian Electricity Rules.

bb) Indian Boiler Regulations (IBR).

cc) Indian Explosives Act.

dd) Indian Factories Act.

ee) Tariff Advisory Committee (TAC) rules.

ff) Emission regulation of Central Pollution Control Board (CPCB).

gg) Pollution Control regulations of Dept. of Environment, Govt. of India

hh) Central Board of Irrigation and Power (CBIP) Publications

ANNEXURE-I
FORMAT OF QUALITY ASSURANCE PROGRAMME

VENDOR'S LOGO , NAME & ADDRESS	MANUFACTURING QUALITY ASSURANCE PLAN	DOC NO:	XXXXX-CAL-QAP-M-0001				
	-	REV NO :	0	1	2	3	4
	ITEM :	DATE :					

CLIENT :		LOCATION :	
PROJECT :		REFERENCE PURCHASE ORDER NO. & DT :	
VENDOR :		REFERENCE APPROVED DATA SHEET :	
SUB VENDOR :		REFERENCE APPROVED DRAWING. NO. :	

ABBREVIATIONS :

QAP - QUALITY ASSURANCE PLAN,
CR - CRITICAL,
MA - MAJOR,
MI - MINOR
SPEC - SPECIFICATION,
TC - TEST CERTIFICATES
P - PERFORM
w - WITNESS
V - VERIFY
CHP - CUSTOMER HOLD POINT

MATL - MATERIAL,
APP - APPROVED,
DWG - DRAWING,
SUPL - SUPPLIER,
PROC - PROCEDURE

AGENCY :

1 - DCPL/PROJECT AUTHORITY
2 - SUPPLIER
3 - SUB-SUPPLIER
4 - MANUFACTURER
5 - THIRD PARTY INSPECTION AGENCY

GENERAL REMARKS

1 THE ITEMS WHICH ARE FALLING UNDER ANY STATUTORY AUTHORITY'S (LIKE I.B.R. ETC.) SCOPE SHALL BE SUBJECTED TO THAT STATUTORY AUTHORITY'S INSPECTION CLEARENCE.

NOTES:

1. EXACT MATERIAL / PROCESS / INSPECTION / TESTS FOLLOWED BY THE MANUFACTURER SHALL BE SPECIFIED
2. EXACT REFERENCE DOCUMENT/ACCEPTANCE STANDARD SHALL BE SPECIFIED
3. IN CASE SPECIFIED ACCEPTANCE STANDARD / NORMS IS OTHER THAN NATIONAL / INTERNATIONAL STANDARDS

. STANDARD / COPY OF THE ACCEPTANCE NORMS FOLLOWED BY THE MANUFACTURER SHALL BE SUBMITTED FOR REVIEW RECORD

4 FINAL INSPECTION DOSSIER SHALL BE PREPARED BY MANUFACTURER & SHALL BE ENDORSED BY INSPECTIONTION AGENCY

Prepared by				Checked by			Approved By		
Revision	R0	R1	R2	R0	R1	R2	R0	R1	R2
DATE									

VENDOR'S LOGO, NAME & ADDRESS	ITEM :	DOC NO:			
		REV NO :	R0	R1	R2
		DATE :			

SL NO.	DESCRIPTION	CHECKS			CATEGORY	REF DOCS	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY		V	REMARKS
		TYPE	METHOD	QUANTUM					P	W		
1	2	3	4	5	6	7	8	9	12	13	14	15
1.00												

Notes:

Prepared by				Checked by			Approved By		
Revision	R0	R1	R2	R0	R1	R2	R0	R1	R2
DATE									

ANNEXURE-II

FIELD WELDING SCHEDULE

PROJECT	:	FWS NO	:
CONTRACTOR	:	REV NO.	:
PACKAGE	:	FIELD WELDING CODE	:
SYSTEM	:	PAGE NO.	:

Sl No.	Drawing No. for Weld Locations & Identi-fication mark	Descrip-tion of parts to be welded	Material specifica -tion	Dimen-sions	Pro-cess of Weld-ing	Type of Weld	Electrode Filler Specifica -tion	WPS No.	Minimum Pre-heat Tempera-ture	Heat Treat-ment Tempe-rature [Holding Time in secs]	NDT Method Quantu m	NDT Speci-fication Number	Accep-tance Norm Ref.	Re-marks

The Field Welding Schedule should be submitted for :

- o Pressure Parts
- o Tanks/Vessels
- o Piping
- o Heavy/Important Structural Steel
- o Heat Exchangers
- o Bus Ducts

5 x 800 MW YADADRI TPS

SECTION IA

(GENERAL TECHNICAL REQUIREMENT)

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

GENERAL TECHNICAL REQUIREMENTS

CONTENT

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1.00.00	CODES AND STANDARDS
2.00.00	RESPONSIBILITY FOR DESIGN
3.00.00	NAME PLATES (RATING PLATES)
4.00.00	SAFETY AND SECURITY
5.00.00	GUARDS
6.00.00	LOCATION AND LAYOUT REQUIREMENTS
7.00.00	OPERATION, MAINTENANCE AND AVAILABILITY CONSIDERATIONS
8.00.00	MATERIALS
9.00.00	LUBRICATION
10.00.00	LUBRICANTS & CONTROL FLUIDS
11.00.00	OPERATION AND MAINTENANCE
12.00.00	PLANT LIFE AND MODE OF OPERATION
13.00.00	PACKAGING & MARKING
14.00.00	PROTECTION
15.00.00	ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT
16.00.00	INSPECTION AND TESTING
17.00.00	TRAINING OF OWNER'S PERSONNEL
18.00.00	DEVIATIONS
	ATTACHMENTS
ANNEXURE-I	LIST OF STANDARDS FOR REFERENCE
ANNEXURE-II	CRITERIA FOR LAYOUT

GENERAL TECHNICAL REQUIREMENTS (AS APPLICABLE)

1.00.00 CODES AND STANDARDS

1.01.00 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.

1.02.00 Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, ASTM, DIN, BS, IEC, IEEE, IS, etc. Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Explosives Act, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc. Wherever required, approval for the plant supplied under the specification from statutory authorities shall be the responsibility of the Contractor.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern.

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Contractor proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Contractor to advise Owner of the resulting effect.

1.06.00 Successful Bidder to furnish two (2) sets of latest of national/inter-national codes and standards to owner.

2.00.00 RESPONSIBILITY FOR DESIGN

2.01.00 The Contractor shall assume full responsibility for the design of the whole and every portion of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Contractor was directly involved in the design work.

2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions elsewhere, at least for continuous 2 years in two different power station.

2.03.00 The successful bidder shall have to carry out surge analysis, BFP transient analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.

2.04.00 The Bid shall include a detailed discussion on the development status of, and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the bidder as reference plants.

2.05.00 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating feed back, etc. are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumptions, etc. shall be clearly brought out to the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications i.e. Base offer shall be as per the technical specifications and the same will be considered for techno-commercial evaluation.

3.00.00 NAME PLATES (RATING PLATES)

3.01.00 Instruction plates, name plates or labels shall be permanently attached to each main and auxiliary item of plant in a conspicuous position. These plates shall be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of plant has been designed to operate.

3.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Direction of flow is also to be engraved.

3.03.00 All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.

3.04.00 The size and location of nameplates shall be subject to Approval of the Engineer.

4.00.00 SAFETY AND SECURITY

4.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and

property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.

4.02.00 Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.

4.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The plant layout shall be designed to localise and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.

4.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.

5.00.00 **GUARDS**

5.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.

5.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.

5.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.

5.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.

5.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure hand hold must be provided on each side of the opening or doorway.

6.00.00 LOCATION AND LAYOUT REQUIREMENTS

The majority of plant and equipment (excluding steam generator and some other auxiliaries) shall all be of indoor installation. A broad list of buildings housing such equipment is given elsewhere in this specification. Layout should facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the plant. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout and other tender layout drawings show the location of major installations and auxiliary buildings. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Bidder may, subject to Owner's approval alter the same to suit the space requirement of the equipment offered.

Bidder may give as an alternative his own preferred layout clearly indicating the advantages and other implications, if any. Such alternative will not be considered for evaluating the bid, but may be considered with the successful Bidder if Owner/Engineer finds the proposal more attractive in terms of techno-economic consideration.

While developing the layout of buildings the following criteria shall be given effect :

a) The minimum width of clear access corridors around equipment shall be 1.2 meter.

b) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.

c) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of 2.5m shall be maintained between the floor and any overhead piping/ cables or other obstruction. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.

d) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.

e) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified

elsewhere in this specification shall be complied with.

f) All rail/road crossings for pipe/cable racks shall be done with minimum 8 meters headroom from top of rail/road to bottom of rack. Similarly top cover over underground pipes/cables shall be minimum one (1) meter. For other detail refer to Annexure-II.

g) Cubicle for operating personnel shall be located at safe place near the equipment.

h) Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or on cable trestle except where approved by purchaser/consultant. In exceptional case, small stretch of outdoor run of interplant cable routing may be taken through cable trench only with the Employer's prior approval.

i) Concept of various mechanical and electrical equipment location and building dimensions (including column-row spacing) as shown in Plot Plan/Floor Plan drawing are to be adhered to. Any departure from this suggestive layout is primarily not recommended.

7.00.00 OPERATION, MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.01.00 Equipment/works offered shall be designed for high availability, high reliability, low maintenance and ease of operation & maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability, availability, operability and ease of maintenance. He shall also furnish details of availability records in plants stated in his experience list.

7.02.00 Ample space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with access ladders shall be provided to facilitate operation and maintenance.

7.03.0 Motorised lifting devices, i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling and carrying out maintenance of any equipment and/or part having weight in excess of 3000 Kg. Suitable beams, hooks etc. for this purpose shall be provided in the buildings.

No lifting arrangement is necessary for part having weight less than 500 Kg. Hoist shall be well protected by environment. Suitable painting and coating covering hoist at outdoor shall be provided.

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, accessories covered under this specification.

7.04.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common

components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.00.00 **MATERIALS**

8.01.00 In selecting materials of construction of equipment, the Contractor shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. Wherever deviations are taken in respect of materials specified, the reasons shall be spelt out clearly in the proposal.

All materials shall be new, and shall be of the quality most suited to the proposed application.

8.02.00 In as far as is possible; materials shall be in accordance with Indian or international standard specifications and shall be used in accordance with Indian or international codes of practice. Where such standards or codes of practice are not available sufficient information shall be provided to allow the Owner to assess the suitability of the material for the particular application.

All materials used shall have performed lengthy satisfactory service in similar or more arduous conditions to those proposed by the Contractor.

8.03.00 All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

9.00.00 **LUBRICATION**

9.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

9.02.00 Non ferrous capillary tubing shall be used throughout.

9.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

9.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant which may drop from operating parts.

9.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

9.06.00 The Contractor shall supply grease gun equipment suitable to service each type of nipple fitted.

10.00.00 **LUBRICANTS AND CONTROL FLUIDS**

10.01.00 The Contractor shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Contractor for initial commissioning, first fill and till COD of the unit.

10.02.00 The Contractor shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Contractor shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **OPERATION AND MAINTENANCE**

11.01.00 The plant shall be designed and constructed so that operation and maintenance manpower requirements are minimised.

The design and layout shall facilitate inspection, cleaning, maintenance and repair. The importance of continuity of operation is second only to that of safety.

11.02.00 Spare parts for equipment shall be interchangeable with the original components and, so far as possible, be of common design and manufacture.

11.03.00 All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another. Further identical equipments shall be provided for similar duties so that the same are interchangeable with one another in totality and component wise.

11.04.00 All heavy parts (500 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul. Any item of plant normally stripped or lifted during periods of maintenance and weighing one tonne or above, shall be clearly marked with its weight.

11.05.00 On completion of commissioning, a complete set of tools for the maintenance of the entire plant shall be provided by the Contractor. This shall include all necessary spanners, special wrenches, extraction equipment and any special tools reasonably required by the Engineer. Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.

11.06.00 All equipment and major valves should be provided with adequate maintenance approach and facility.

12.00.00 PLANT LIFE AND MODE OF OPERATION

The complete plant including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of thirty (30) years under the prevailing site conditions and for the type of duty intended.

The critical components of the Steam Generator, Turbine-Generator and Auxiliary equipment, the life of which is limited by time and temperature dependent mechanisms such as thermal stress, creep and low cycle fatigue, are to be designed considering expected (hot, warm and cold) start-up, shut-down and cyclic load variations.

The allowable stresses shall be reduced so that life expectancy to minimum 2,00,000 hours of operation can be achieved. The Bidder shall discuss this aspect in his technical proposal.

The unit would be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand.

The expected start-ups should be considered as minimum
(Based on HPT metal temperature)

Cold start-up (>72 hrs. shutdown)	:	6 per year
Warm start-up (between 10 to 72 hrs. of shutdown)	:	40 per year
Hot start-up (less than 10 hrs. shutdown)	:	160 per year

13.00.00 PACKAGING & MARKING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

As per the information available, the dimensions of OD consignment for transportation of the equipment by rail (if any equipment to be handled through rail transportation) are as below :

a)	Width of the Package (from centre-line of rails - 1.6 metres on both sides)	:	3.2 Meters
b)	Height of the package from rail top	:	4.47 Meters

The above indicates the dimensions which can be normally transported on the

wagons without infringement of the "moving gauge". This is however not indicative of the consignment which can be carried out with infringement of "moving gauge" duly authorised and approved by the Indian Railways. There may be difference between the "moving gauge" and the "fixed structure gauge" and consignments infringing the "moving gauge" can be moved after investigation regarding possible infringement with the fixed structures. As the critical fixed structures in each route are different, consignments infringing moving dimensions have to be individually investigated to select a route and also determine the restrictions under which such movement is to be carried out. Such routes selected or other mode of transport envisaged is to be clearly brought out in the proposal wherever transport of over dimensional equipment is involved.

Bidder to consider unloading of material delivered through rail transportation, at near by railway station/ site unloading siding. The subsequent transportation up to project work place shall be considered by road only. All unloading and handling equipment both at railway station siding and at project site shall be arranged by the Bidder. Necessary arrangement to be organized with the railway authority for such purpose shall also be under the scope of services of the Bidder. Bidder may consider entire material delivered up to site through rail transportation only.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

For imported equipment and material, suitable port facilities may be used in which case material may be transported from the port by tractor-trailer. Bidder may consider this aspect.

14.00.00 **PROTECTION**

Equipment having antifriction or sleeve bearings shall be protected by weather-tight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.

Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings 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. All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs. Female threaded openings shall be closed with rough usage covers or forged steel plugs. The closures shall be taped to seal the interior of the equipment. Open ends of

piping, tubing and conduit shall be sealed and taped.

Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

15.00.00 ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

15.01.00 Environment Protection

The plant shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to restrict pollution from the liquid effluent and stack emission within the limits as given below with due consideration of Environment (Protection) Rules 1986 as amended till date.

In case the Ministry of Environment & Forest stipulate any other conditions not specified hereunder while clearing the project shall be complied with the plant by the contractor.

15.01.01 For Liquid Effluent

a) Provision laid down in schedule-I for Thermal Power Plants and also in Schedule-VI. General Standards for discharge of Environmental pollutants Part-A : Effects of Environmental (protection) Rules 1986, as amended till date.

b) Any specific requirement of State Pollution Authorities over and above the above stipulation.

15.01.02 For Air Emission

a) Suspended Particulate Matter i.e. dust burden at chimney outlet - Maximum 50 mg/Nm^3 (with worst coal and one field out at TMCR).

b) NO_x - 365 ppm Max. or 750 mg/Nm^3 (Equivalent NO_2).

c) SO_2 - Concentration based standard 2000 mg/Nm^3. Load based standard 0.2 metric tonne /MWe/day (for first 500 MW and 0.1 metric tonne/MWe/day for rest of the capacity above 500 MW)

In absence of Indian Standard for emission from power plants as on date, for certain gaseous effluents, the internationally accepted World Bank Standard is to be followed. Indian Standard for emission of power plants are under formulation. Should this standard is published before finalisation of the contract, the bidder has to comply the more stringent of the above norm or the new Indian Standard.

The bidder shall include in his scope all necessary equipment and measuring instruments to comply with above requirements. Location and accessibility of the instruments shall be properly coordinated.

15.02.00 **Noise Level Requirement**

The plant will be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

a) Maximum noise level shall not exceed 85 dB (A) when measured at 1.0M away from the noise emission source.

b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, `Ambient Air Quality Standards' in respect of noise.

c) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the contractor shall comply with the requirement.

An exception will be made for the plant at startup operations and other big pressure reducing devices operating during emergency periods and for the safety valves.

16.00.00 **INSPECTION AND TESTING**

16.01.00 **Inspection and Tests during Manufacture**

16.01.01 The method and techniques to be used by the Contractor for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner prior to the Award of Contract.

16.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

16.01.03 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.

16.01.04 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 Contractor may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The Contractor 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. Distribution of six (6) copies of Test Certificates for approval will be two(2) copies to owner and four(4) copies to consultant. These four(4) copies will be further distributed by consultant after approval to owner, site and bidder. One copy will be retained with the

consultant for record purpose.

Further, nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere. Distribution of nine (9) copies of Shop Test Certificates for approval will be Two (2) copies to owner, Three (3) copies to site, Two (2) copies to consultant, Two (2) copies to owner's library / record.

16.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Owner's Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer along with Defect Map.

16.01.06 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 Contractor shall allow for trial assembly prior to despatch from place of manufacture.

16.01.07 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 or any other test as required by approved QAP/ Material specification.

16.01.08 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 or as required by design code of that part, for a period not less than one hour.

16.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

16.01.10 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 butt welding joints shall be radiographed.

16.01.11 Statutory payments in respect of IBR approvals including inspection for design and manufacturer of equipment shall be made by the Bidder. All payment for erection and testing at site (i.e. under IBR jurisdiction) shall also be made by the Bidder. In such case Contractor's scope shall also be extended to preparation of all necessary documents, co-ordination and follow-up with IBR authorities for above approval.

16.02.00 **Performance Tests at Site**

16.02.01 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 Contractor on site under normal operating conditions. The Contractor 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.

16.02.02 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.

16.02.03 The Contractor 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.

16.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

17.00.00 TRAINING OF OWNER'S PERSONNEL

The Contractor shall extend all possible assistance and co-operation to the Purchaser regarding the transfer of technology and developing expertise in the area of engineering operation and maintenance of the Plant.

Number of man-days of training as mentioned below shall be included in his Tender.

17.01.00 Training at Contractor's Premises

The Contractor shall conduct training of sixty (60) engineers of the Owner on engineering, operation and maintenance of the Plant at the Contractor's or Associates or Sub-contractor's premises where adequate training facilities are available during the design and manufacturing stage of the Contractor.

The total man-months for training of engineers shall be maximum sixty (60), having following indicative break-up :

Discipline	No. of Engineers	No. of Man-month
Operation	20 heads	20
Maintenance Boiler, Turbine, Mechanical	20 heads	20
Electrical Maintenance	8 heads	4
Control & Instrumentation	8 heads	4
Maintenance Planning	4 heads	2

However, the details of the training programme will be discussed and finalised with the successful Bidder.

The training may also be arranged by the Contractor in any Plant where the equipment manufactured by the Contractor or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Contractor. All expenses inherently related to the training shall be borne by the Contractor and shall include but not limited to travel expenses (international and inland fares), lodging and per diem charges as well as medical insurance, instructors fee, programme and miscellaneous cost to be incurred during the training.

The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the area of engineering, operation and maintenance and as trainers for in-house technology transfer programme of the Purchaser.

The Contractor shall be responsible for the development of the Training Module and Programme Schedule which shall be submitted to the Purchaser for approval.

The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee.

Three (3) sets of the materials included in the training modules shall be handed over to the Purchaser upon completion of the training. An evaluation shall be jointly undertaken by the Contractor and the Purchaser's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

The content of the training programme shall include but not be limited to:

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.

2. Plant operation and systems training for operators including simulator training as applicable.

3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

Said training programme shall be submitted to the Purchaser for approval.

The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the Plant.

The Contractor shall provide qualified English speaking instructors and training

coordinator(s) during the tenure of the training programme.

17.02.00 **Operation and Maintenance Training at Site**

The Contractor shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Contractor's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final Acceptance of the first Unit.

The following instructors shall be at the Site continuously during the training :

a) One (1) for Steam Generator and Auxiliaries ;

b) One (1) for Turbine Generator and Auxiliaries ;

c) One (1) for Electrical Works ;

d) One (1) for Instrumentation and Control (Boiler and Auxiliaries) ;

e) One (1) for Instrumentation and Control (Turbine and Auxiliaries).

17.03.00 **On-the-Job Training**

During the period of pre-commissioning, commissioning and trial operation, the Purchaser shall provide operation and maintenance personnel to assist the Contractor in the operation and maintenance of his supply and work under the direction of the Contractor for the purpose of on-the-job training.

The Purchaser shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The Contractor shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.

17.04.00 For detail C&I training refer to Volume-VI, Section-9.

18.00.00 **DEVIATIONS**

The Bidder is required to submit with his proposal in the relevant schedules a detail list of any and all deviations taken by him clearly without any ambiguity. In the absence of such a list it will be understood and agreed that the Bidder's proposal is based on strict conformance to this specification and no post-contract negotiations would be allowed in this regard.

Unless otherwise specifically indicated in the deviation list, it will be construed and agreed that details indicated in documents & drawings furnished by the Bidder along with the offer is in-line with the specification requirement.

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

a) International Standards Organisation (ISO).

b) International Electro-technical Commission (IEC).

c) American Society of Mechanical Engineers (ASME).

d) American National Standards Institute (ANSI).

e) American Society for Testing and Materials (ASTM).

f) American Institute of Steel Construction (AISC).

g) American Welding Society (AWS).

h) Architecture Institute of Japan (AIJ).

i) National Fire Protection Association (NFPA).

j) National Electrical Manufacturer's Association (NEMA).

k) Japanese Electro-technical Committee (JEC).

l) Institute of Electrical and Electronics Engineers (IEEE).

m) Federal Occupational Safety and Health Regulations (OSHA).

n) Instrument Society of America (ISA).

o) National Electric Code (NEC).

p) Heat Exchanger Institute (HEI).

q) Tubular Exchanger Manufacturer's Association (TEMA).

r) Hydraulic Institute (HIS).

s) International Electro-Technical Commission (IEC) Publications.

t) Power Test Code for Steam Turbines (PTC).

u) Applicable German Standards (DIN).

v) Applicable British Standards (BS).

w) Applicable Japanese Standards (JIS).

x) Electric Power Research Institute (EPRI).

y) Standards of Manufacturer's Standardization Society (MSS).

z) Bureau of Indian Standards Institution (BIS).

aa) Indian Electricity Rules.

bb) Indian Boiler Regulations (IBR).

cc) Indian Explosives Act.

dd) Indian Factories Act.

ee) Tariff Advisory Committee (TAC) rules.

ff) Emission regulation of Central Pollution Control Board (CPCB).

gg) Pollution Control regulations of Dept. of Environment, Govt. of India

hh) Central Board of Irrigation and Power (CBIP) Publications.

ii) The Air Prevention and Control of Pollution Act.

jj) The Environmental Protection Act

kk) The Public Liability Insurance Act.

ll) The Forest Conservation Act

mm) The Wildlife protection Act.

nn) The EIA Notification, 1994.

oo) IS: 14665-Specification for Electric Traction Lift

pp) Any other statutory Codes/Standards/Regulations

CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

	ITEM	SPECIFICATION REQUIREMENT
A.	Site conditions to be considered	
1.	Prevalent wind direction	See wind-rose in plot plan. Also refer Metrological Data.
B.	Layout Requirements	
1.	Maximum permissible slope in	
a)	Rail track	1 in 400
b)	Road	1 in 30
c)	Sides of unpaved embankment	1 in 2
2.	Required road width	
a)	Main roads	Refer VII-A, B, C.
b)	Auxiliary interconnections	Refer VII-A, B, C.
c)	Road to the power house unloading bay :	
	• Only for entry to the unloading bay	Yes
	• To pass through the unloading bay	No
3.	Required minimum horizontal distance between the nearest points of	
a)	Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b)	Electrical transformer and any other building/facility	As per the Tariff Advisory Committee/ LPA Rules
c)	Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee/ LPA Rules
d)	Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Explosives Act) and Indian Petroleum Code

4.	Required minimum vertical clearance	
a)	Under pipes/cable racks at road crossings	8.0 Metres
b)	Soil coverage over underground pipes	1.0 Metre (minimum)
5.	Railway Wagon clearance	Rules of the Indian Railways
6.	Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres
7.	Required level, above the local developed grade level, of	
a)	top of all roads	150 mm above FGL
b)	all outdoor paved areas	100 mm above FGL
c)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes
d)	Green belt around power plant area	As per environmental guidelines of MOEF, Govt. of India.

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

A.	Minimum clear space required at all working and walking areas for operating & maintenance personnel	
1.	Horizontal, in all directions	
a)	Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60°C.	1200 mm
b)	Adjacent to any other plant facilities (including walls/structures)	1000 mm
2.	Vertical (head-room clearance)	
a)	Under any pipe/equipment surface of temperature exceeding 60°C and any electrical cables or other electrical items.	2.5 Metre
b)	Under any other plant facilities (including structures, pipes etc.)	2.5 Metre

	ITEM	SPECIFICATION REQUIREMENT
3.	For all areas where any equipment (including trucks, trolleys and other material handling equipment) will move or maneuver.	Minimum 500 mm clear in all direction from the outer edges of the equipment
4.	Minimum clear hand space required for	
a)	The application of thermal insulation	100 mm
b)	Welding work	150 mm
c)	Bolt tightening	150 mm
B.	Floors, platforms, staircase, ladders, walls, doors & windows	
1.	Statutory Requirement	As per the regulations of Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, Local Municipal Rules, etc.
2.	Operation & Maintenance Requirement	
a)	Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
b)	Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments, etc. to be operated, observed and/or to be frequently (more than once a month) maintained.	Yes
3.	Plinth level of all buildings, above the finished grade level	500 mm
4.	Minimum access opening required (with rolling shutter) for transportation, wherever entry of truck for material handling is envisaged	3.5M wide x 4M high or, more depending upon the equipment size to be handled.

ITEM	SPECIFICATION REQUIREMENT
C. Other Maintenance Requirement	
1. Generator stator handling In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.	Yes
2. Maintenance of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, compressors, blowers, heat exchangers, fuel oil pumps, filters etc.	Shall be possible without disconnecting or dismantling any piping/ducting.
3. Overhauling and handling of the casings for the above items	Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4. Crane Approach Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.	Yes
D. Central Control Room All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room.	Yes
The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration. However, as a guide line, following features are given :	
a) False ceiling and false flooring shall be provided.	
b) Uniform height, colouring schemes for cabinets etc. shall be available.	

ITEM		SPECIFICATION REQUIREMENT
c)	The total area of floor space covered by Control Consoles/Panels in the Control Room shall not exceed 15% of floor area.	
d)	No opening shall be provided from Boiler side.	
e)	Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor.	
f)	Cable entry for the panels/consoles shall be from bottom and suitable openings shall be provided.	
g)	The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX.	
h)	Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.	
i)	Basic amenities like toilet, Tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room.	
E.	Toilet and drinking water facility	Required in all buildings and on all floors wherever operating personnel are to be deployed.

PROJECT MANAGEMENT AND SITE SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)

PROJECT MANAGEMENT AND SITE SERVICES

1.00.00 PROJECT MANAGEMENT SERVICES

1.01.00 Responsibility

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. Responsibilities of this project Management team shall cover the areas listed below :

a) Planning and Monitoring

b) Engineering Management

c) Contracts Management

d) Project Safety Management

e) Quality Assurance, Inspection & Expediting

f) Construction Management

g) Spares Management

h) Erection & Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project. He should have adequate financial power and authority to give decision.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.00, who, in turn, will report to the Project Manager for all matters relative to this contract.

1.02.02 Central Co-ordination Cell

The central coordination cell shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or

references made by Owner and his Consultants without having the need to refer to his headquarters each time.

1.02.03 Site Organisation

The site should have a competent construction manager for all site operations with adequate financial power and sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.

1.02.04 Organisation Chart

The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation.

1.03.00 **Implementation Schedule**

The schedule for the completion of the Project would be as follows :

		Period in Months from Zero date (Taken as advance payment date of EPC Package)
a)	Boiler Hydro-test	By Bidder
b)	Boiler light up	By Bidder
e)	Commercial operation	50

To achieve these targets, the Contractor shall furnish to the Owner, various schedules as defined below:

1.03.01 Engineering Schedules

These schedules shall cover various design submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant/systems/ equipment item covered in the scope of this specification.

1.03.02 Manufacturing Schedule

The Contractor shall submit to the Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Intent (LOI). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.

1.03.03 Erection Schedules

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/ agreements with the Owner subsequent to the award of contract.

1.03.04 The successful Bidder shall have to provide all the above schedules (i.e. 1.03.01, 1.03.02 & 1.03.03) in a tabular form in addition to that in the form of L2 & L3 networks and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.03.05 The Contractor shall provide the Owner the original disc/software for all such schedules alongwith requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award of contract. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software, SAP.

1.04.00 **Detailed Responsibilities**

1.04.01 Planning & Monitoring

a) Planning

The Bidder shall prepare a Master Network Schedule in the form of PERT network.

The network shall be prepared on a Work Breakdown Structure for the project which sub-divides the project into a set of manageable systems/sub-systems. The master network will identify milestones of key events for each system/package in the areas of engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) Monitoring & Progress Reporting

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

i) Report on key milestones.

ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.

iii) Action needing attention of the Owner/Consultant.

iv) Detailed packagewise status of engineering submissions, quality plan submissions and approval, procurement manufacture and despatch.

The monthly report generated from the site office should necessarily include:

i) Report on key milestones.

ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.

iii) Action needing attention of the Owner/Consultant.

iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of fax/e-mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

1.04.02 Engineering Management

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for engineering activities.

Based on (L-2) network, the Contractor shall further develop the Level-3 (L-3) network for engineering activities which will indicate schedule for data availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of issue of Letter of Intent and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software as well as in other format / software suitable to Owner.

The engineering management team should also co-ordinate all interface engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

TSGENCO is implementing SAP ERP. Hence the bidder apart from submission of the hard copies shall upload all the documents, drawings etc. in soft format in the relevant C- folder environment (web based) and comply with the additional requirements, if any.

1.04.03 Contracts Management

Based on the master network, the Contractor shall submit L-2 programmes of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programmes would be submitted in 2 months time from the date of award of contract and finalised within one (1) month thereafter. The Contractor will also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor should also submit L-3 programmes for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Owner or their authorised representative(s) before further manufacture can take place. These L-3 programmes for the manufacture and despatch would clearly identify responsibilities of the Contractor, sub-Contractor and Owner. These networks shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programmes would be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of boughtout items, detailed shipping schedule and cash flow statement for Owner's approval.

1.04.04 Quality Assurance, Inspection and Expediting

The Contractor shall submit the list of manufacturers/sub-vendors from whom the equipment are expected to be procured and the quality assurance plans thereof for the manufacture shall be approved by the QA group of Owner before the manufacture is commenced. The list of major suppliers would be submitted along with the bid and this shall be mutually discussed and approval will be given by the Owner during contract negotiation meeting prior

to placement of Letter of Intent. This approved list will be binding to the bidder. In the said list, Owner reserves the right to include reputed/reliable vendors of his own choice. Regarding the various other sub-vendors, the list would be submitted within six (6) months of the award of the contract that shall be scrutinized by the Owner to accord approval. In such list Owner reserves the right to include vendors of his own choice. No further vendor approval will be given after twelve (12) months. On the quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

Quality assurance/Inspection group of Owner or its representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance which will enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site upto erection. All despatch details & item lists shall be made available to both Owner & site immediately after shipping.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.04.03 above.

1.04.05 Construction Management

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Intent, the Contractor shall submit a programme of construction/ erection/ commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These programmes would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based on the site conditions would be prepared based on these L-3 programmes. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/ system supplier.

1.04.06 Spares Management

Alongwith the proposal for the plant and equipment, the Contractor shall also submit proposals/schedule for the following:

a) Mandatory spares

b) Recommended spares

While the award for mandatory spares will be finalised at the time of the award of contract, recommended spares will be finalised thereafter.

1.05.00 **Project Progress Review Meetings**

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution of the project will be held initially at least once in two (2) months at Hyderabad/site/ at the discretion of the Owner.. During peak period it may be held once in a month. These meetings will be attended by reasonably higher officials of the Contractor and their leading sub- contractors and will be used as a forum for discussing all areas where progress needs to be speeded up. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings between the Contractor and the Owner will be decided upon as part of erection coordination procedure. Site co-ordination meeting may be held on weekly basis.

1.06.00 **Owner's Consultant**

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.01.00 above. The details of interaction and procedures for coordination between Owner / Owner's Consultant and Contractor/ Contractor's project management team shall be finalised during contract negotiations.

1.07.00 **Commissioning Management**

1.07.01 For commissioning of the various equipment/system covered under the scope of contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

a) Steering Committee
b) Commissioning Panel.
c) Working Parties
d) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the

following manner and submitted for Owner's approval :

a) Field Quality Plan

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least six (6) months before their actual commissioning :

i) Establish design data against which Plant Performance will be compared.

ii) Set-out the testing objectives and proposals.

iii) Define the documentation required.

b) Testing/Commissioning Schedule

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

c) Standard Check Lists

Standard check lists are intended for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

1.07.03 Test Reports

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-a-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

2.00.00 **SITE SERVICES**

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

2.01.00 Arranging material despatch from the shop by rail/road and/or sea as applicable.

2.02.00 Monitoring movement of materials & follow-up as necessary with Railways, road transport, port clearance etc. from the time of despatch F.O.R. works/ F.O.B. port of shipment by Contractor till receipt of the same at site.

2.03.00 Unloading of materials at Railway Station/Railway Siding inside project area/ Road Transportation, transportation to site store, assessment of lost/ damaged items in transit and arranging insurance claims and replacement of lost/damaged items. The Contractor shall submit to the Engineer a report detailing all the receipts during the week as well as storing, preservation of material at site.

2.04.00 Issuing materials from site store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.

2.05.00 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.

2.06.00 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment & services for chemical cleaning, steam blowing as well as performance guarantee tests.

Apart from Boiler, proper chemical cleaning shall be carried out in following pipe lines/equipment before commissioning

a) Deaerator

b) Boiler feed suction, recirculation leak-off lines

c) Boiler Feed discharge line by passing heaters

d) Attemperation lines

e) Condensate suction & discharge piping upto deaerator by passing the feed water heaters.

f) Fuel oil lines.

Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary shall also be in the scope of the Bidder.

Safe disposal of effluent after chemical cleaning shall be done by the contractor.

2.07.00 Supply and application of the final paints and first fill lubricants on all the equipment to be erected under this specification. Supply of chemicals, lub oils and other consumables upto COD.

2.08.00 For the purpose of erection and commissioning the Contractor's scope of work shall include but not be limited to the following :

2.08.01 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to

be rendered under this specification.

2.08.02 Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.

2.08.03 Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection work except those listed under exclusion elsewhere in this specification.

2.08.04 Construction of all civil/structural/architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other incidental civil activities as detailed elsewhere.

2.08.05 All structural steel fabrication and erection work as detailed elsewhere in the specification.

2.08.06 Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.

2.08.07 Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives, Electrical Inspector etc. for respective portions of work under the jurisdiction of such statutes or laws.

2.08.08 The Contractor shall provide `Industrial Relations' unit and `Medical' unit to take care of his erection staff and the Owner shall have no obligation in the regard.

2.08.09 The successful Bidder shall arrange for Tower cranes of adequate capacity for speedy erection activities.

2.09.00 **Site Organisation**

The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site.

On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel

proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

2.10.00 **General Guidelines for Field Activities**

2.10.01 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.10.02 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication.

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

2.10.04 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work 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 of 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 action in writing to the Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

2.10.05 The Engineer 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 co-ordination work between various Contractors as set out earlier.

2.10.06 The works under execution shall be open to inspection & supervision by the Owner's engineer at all times. The Contractor shall give reasonable notice to the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.

2.10.07 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.

2.10.08 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.

2.10.09 All the works such as cleaning, checking, leveling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipments for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.

2.10.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Engineer and as per the Standards.

2.10.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Engineer, will have to be done by the Contractor.

2.10.12 Attachment welding of necessary instrumentation tapping points, thermocouple pads, root valves, condensing vessels, flow nozzles and control valves etc., both for regular measurement and performance testing to be provided on equipment, its auxiliaries or pipelines covered within the scope of this tender, will also be the responsibility of the Contractor and the same will be done as per the instructions of Engineer. The erection and welding of all above items will be the Contractor's responsibility, even if :

a) Product groups under which these items are re-leased are not covered in the scope of this tender.

b) Items are supplied by an agency other than the Contractor.

2.10.13 Preservation of all materials/equipment under custody of the Contractor during storage, pre-assembly & erection, commissioning etc., shall be the responsibility of the Contractor. All necessary preservatives and consumables like paints, etc., shall be arranged by the Contractor. Necessary touch up painting, periodic application of preservatives/paints on pressure parts/other equipment even after erection until completion of work shall be carried out by

the Contractor. The Contractor shall fabricate piping, install lub oil systems and carry out the acid cleaning of fabricated piping. The Contractor shall also service the lub. oil system, carryout the hydraulic test of oil coolers, etc.

2.10.14 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Engineer, with all the necessary tools & tackle, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.

2.10.15 Additional platforms for approaching different equipment as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.

2.10.16 Equipment and material which are wrongly installed shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner/ Consultant.

2.10.17 Before erection of any equipment on a foundation, the Contractor shall check and undertake if necessary rectification of foundation bolts, reaming of holes, drilling of dowels, matching of bolts and nuts, making new dowel pin, etc.

2.10.18 Assistance for calibrating/testing the power cylinders, valves, gauges, instruments, etc., and setting of actuators coming under various groups shall be provided by Contractor.

2.10.19 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.

2.10.20 Structural materials required for the supporting/operating platforms required for the valves at various levels for the same operation of valves will be arranged by the Contractor.

2.10.21 For civil, structural and architectural works, volume VII-A, VII-B, VII-C may be referred. For Instrumentation and Electrical works Vol. VI, V-A and V-B may be referred.

2.11.00 **Safety**

Safety and overall cleanliness of work site shall be given top priority.

2.11.01 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.

2.11.02 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be

handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.

2.11.03 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.

2.11.04 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.

2.11.05 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be done by the Contractor and certified copies shall be supplied to the Owner. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.

2.11.06 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.

2.11.07 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.

2.11.08 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.

2.11.09 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.

2.11.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.

2.11.11 All safety precautions shall be taken for welding and cutting operations as per IS-818.

2.11.12 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

2.12.00 **Taking Delivery & Storage**

2.12.01 The Contractor shall arrange issue of all equipment and materials to be erected under the contract from the stores/open yard at site by signing on standard indent forms. After completion of work, detailed auditing of the

materials so issued shall be submitted to the Owner.

2.12.02 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.

2.12.03 All empty containers, packing materials, gunny bags, transport frames and also surplus and unused materials reconciliation prior to completion of contract shall be the property of the Owner and returned to the Owner by the Contractor.

2.13.00 **Site Welding & Heat Treatment**

2.13.01 Welding shall be done in accordance with IS-813, IS-816, IS-9595 & other relevant IS/International standards and as per instructions of Contractor. Only those welders, who are qualified as per IS-817 for ordinary welds and as per IBR/ASME Section-IX for high pressure welds, shall be employed in the job.

2.13.02 All welders shall be tested and approved by Engineer before they are actually engaged on the work even though they may possess the requisite certificates. The Owner reserves the right to reject any welder without assigning any reason. The welder identification code as approved by the Engineer shall be stamped by the welder on each joint done by them. The Contractor will be responsible for the periodic renewal, re-testing of the welders as demanded by Owner.

2.13.03 The Engineer is entitled to stop Contractor's any welder from his work if his work is unsatisfactory for any technical reason or there is a high percentage of the rejection of joints welded by him, which in the opinion of Engineer will adversely affect the quality of welding even though the welder has earlier passed the tests. The welders having passed the tests do not relieve the Contractor from his contractual obligations, to check the performance of the welders.

2.13.04 All charges for testing of welders including destructive and non- destructive tests if conducted by Owner or by the inspection authority at site shall have to be borne by the Contractor. The necessary test materials and consumables will have to be arranged by the Contractor and all testing facility made available, as required.

2.13.05 All welded joints shall be subject to acceptance by Engineer. Inspection of welds shall be in accordance with IS-822 or equivalent code.

2.13.06 Preheating/post heating and stress relieving after welding are part of fabrication and erection work and shall be performed by the Contractor in accordance with the instruction of Engineer. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the Contractor shall have to arrange for the labour, heating elements, thermocouples, compensating cables, insulation materials like mineral wools, asbestos cloth, ceramic beads, asbestos rope, etc. required for the heat-treatment and stress relieving works. During pre- heat/stress relieving operations, the temperature shall be measured at one or more points as required by attaching thermocouples and recorded on a continuous printing

type recorder. All the record graphs for the heat treatment works carried out shall be got signed by the Engineer prior to the commencement of each cycle and handed over to Engineer on completion. The graphs will be the property of Owner. The Contractor has to provide thermo-chalks temperature recorders, thermocouple attachments, units, graph sheets, etc. required for the job and maintain them in good condition.

2.13.07 All electrodes shall be baked and dried in the electric/electrode drying oven to the required temperature and for the period specified by the Engineer before they are used in erection work. The electrodes used shall be as per IS-814, IS-815, IS-1442, IS-7280 and other codes as applicable, and shall be of approved reputed manufacture. The electrodes shall meet the requirement of the pipe material. No electrode manufactured more than 12 months ago and the type covered under certificate issued after conducting tests more than 6 months ago shall be used. All electrodes shall be preserved at works and at site as per manufacturer's recommendations.

2.13.08 Oxy-acetylene flame or Exothermic chemical heating for stress relieving is not permitted. Heating shall be by means, of electric induction coil or electric resistance coil.

2.13.09 It may become necessary to adopt inter layer radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuation of the work and making necessary arrangement for carrying out the above work.

2.13.10 Gas tungsten arc welding process (TIG) shall be adopted for all root pass welds except for structural works until 4.75 mm thickness is deposited. Subsequent welding after root pass can be carried out by manual metal arc welding with coated electrodes. For pipes of thickness less than 6 mm the entire welding has to be carried out by TIG welding.

Fillet weld shall be made by shielded metal arc process as per applicable codes.

However, the Engineer will have the option of changing the method of welding as per site requirement. The method adopted for manual arc welding shall be weaving technique and the width of weaving shall not exceed 1.5 times of the dia. of the electrode.

In case of deviation from welding process and electrodes, the Contractor shall take approval of the Owner prior to adoption of same.

2.13.11 The root pass for butt joints shall be such as to achieve full penetration with complete fusion of root edges.

2.13.12 Each pass shall be cleared and freed of slag before the next pass is deposited.

2.13.13 On completion of each run, craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

2.13.14 Each layer of welding shall have an even and smooth appearance.

2.13.15 Welding sequence shall be adjusted in such a way that distortion due to welding shrinkage is minimised. Further any movement, shock or vibration during welding shall be avoided to prevent weld cracks.

2.13.16 Proper protection of welders and the work shall be taken during periods of rain. No welding shall be carried out when surface to be welded are wet from any cause.

2.13.17 Following will be stages of inspection during welding :

a) Two pieces to be joined shall be individually checked for the weld edge preparation and profile dimensionally and to the template. Dye penetrant check shall be carried out on edge prepared surfaces at random. The percentage will depend upon on criticality as specified by Engineer.

b) Joint fit up will be a stage of inspection. Misalignment after fit up may vary from 0.3 mm to 1.6 mm depending on outside diameter and thickness.

c) All joints shall be offered for visual inspection after root run. Subsequent welding should be made only after the approval of root run.

2.13.18 All welded joints shall be painted with anti-corrosive paint immediately on completion of radiography and stress-relieving.

2.14.00 For further details on procedures of work at site on civil, architectural, electrical and instrumentation & control services, refer Volume : V, VI & VII of this specification.

3.00.00 PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)

3.01.00 Contractor shall submit as part of its Work Scope detailed documentation as outlined in this section and / or required by the Technical Requirements. The content and format of the documentation to be submitted are subject to Owner's approval.

3.02.00 Contractor shall utilise a computer based system for control and management of project documentation. The system must be capable of producing customized reports and information on demand. This control system should have been successfully applied to similar projects and be familiar to the project control personnel selected. Contractor's detailed project documentation plan shall identify all documentation requirements for the project, the party responsible for production of the document, the basic content of the document and the required timing for issue. This plan shall include, but not be limited to the details of all Drawings to be produced, plant specification / definition documentation, equipment orders and manuals. The documentation identified shall be entered into the computer based control system The database thus created shall be capable of being sorted and

ordered on a variety of selected parameters such as document type, subject description, responsible party, start date and finish date, to enable review and update to be conducted only on those documents which are relevant.

3.03.00 Regular documentation control progress reports shall be prepared by the Contractor to record the status of documentation. In the event either Party or Engineer expresses concern with the content of such progress reports, the accuracy of progress reports, status of documentation production and other such matters, the concern will be identified to the Project Manager. Within five days of notification of this concern, the Project Manager will attend a meeting with relevant Owner Representatives and provide details of specific actions to be initiated to satisfactorily overcome the difficulties identified. It will be the Project Manger,s responsibility to initiate whatever action is necessary to ensure that the production of documentation is completely in accordance with Project Information Management System (PIMS).

3.04.00 Within 90 days after Effective Date of Contract, the Contractor shall establish an integrated PIMS which will support the needs of Project and management, detail design and engineering, procurement, construction and operation, and maintenance.

PIMS shall utilise software which links various software and database programs to form a composite system. The typical scope of PIMS shall include, but not be limited to, the following:

(a) Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. The Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. This data shall include, but not be limited to, the following:

(i) System descriptions and design requirements and design criteria

(ii) Equipment and material technical specifications for all engineering disciplines

(b) Detail engineering data to create flow diagrams, plant arrangements, piping configurations, equipment layout and design, electrical and instrumentation systems, structures, and other systems. The software tool used shall be capable of manipulation and storage of plant layout and design information. The 3D model of the plant shall also contain details of the various components like pipe, structural steel work, etc., and relevant information shall be available on-line from relevant data base. Software shall be multi-user, multi-access nature allowing the designers of Contractor and major Sub-Contractors, if required, to work in interactive real time environment and software shall be capable of interference checking. The software shall allow access to different types of information held in the database. It shall estimate the type and quantity of materials required to build the plant and it shall be possible for such data to be taken off the system at any time.

(c) Construction data to monitor and manage site activities, including material control, scheduling and progress, quality control, start-up and testing, operation, maintenance, training, and all other site functions.

(d) Plant design and construction records to provide data for safe and efficient maintenance and operation. Records to include may be maintenance schedule, man power tracking, tools, spare parts, and test equipment inventory, equipment list, drawing, control, technical specifications, and equipment instruction manuals.

3.05.00 The PIMS shall be installed in a distributed processing array system and operated through personal computer work stations at the Contractor's site office. A complete integrated system shall be implemented. This system shall be utilised by Contractor during the Project execution.

ENGINEERING SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	DESIGN COORDINATION MEETING
3.00.00	CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS
4.00.00	GUIDELINES FOR ENGINEERING SERVICES
5.00.00	OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS
6.00.00	PLANT HANDBOOK
7.00.00	CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE
8.00.00	TENDER STAGE DOCUMENT SUBMISSION

ATTACHMENTS

ANNEXURE-1	DISTRIBUTION SCHEDULE

ENGINEERING SERVICES

1.00.00 **GENERAL**

1.01.00 As part of the overall project management activity, the Contractor shall be responsible for proper engineering and co-ordination of activities during various phases of execution of the contract. The Contractor shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Engineer or the Review Consultant shall interact on matters related to engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Contractor and shall be responsible for all engineering co-ordination. The Owner/Consultant/Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Contractor or on matters involving the Contractor, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the contractors. However such interaction will not, under any circumstance, dilute the responsibility of the Contractor to provide a fully engineered and co-ordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of engineering information will be mutually agreed and finalized between the Owner and the Contractor.

2.00.00 **DESIGN COORDINATION MEETING**

The Contractor and his sub-vendors will be called upon to attend design co-ordination meetings with the Engineer, other Contractors and the Consultants of the Owner during the period of execution of contract. The Contractor including his sub-vendors shall attend such meetings at their own cost at Owner's or Consultant's office in Kolkata or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 **CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS**

The Contractor shall agree to cooperate with the Owner's other Contractors and Consulting Engineers 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 efforts. The Engineer shall be provided with copies of all correspondences addressed by the Contractor to other Sub- contractors and Consulting Engineers in respect of such exchange of technical information.

4.00.00 **GUIDELINES FOR ENGINEERING SERVICES**

4.01.00 Prior to commencement of the engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed engineering work.

4.02.00 Engineering work shall be performed on modern and proven concepts and internationally accepted good engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Contractor.

4.03.00 At any stage during the performance of assignment, the Contractor may be required to make certain changes/modification/improvements in design/ drawing/other documents which are applicable to 800 MW Unit, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the plant and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution / operation of similar units. Such changes / modifications/ improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and scope of the Contractor.

4.04.00 During the course of review of detailed engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.

4.05.00 During the course of review of detailed engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.

4.06.00 It is not the intent to give details of every single task covered in the total engineering work to be carried out by Contractor, however, all engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Contractor. Broadly, the following are the minimum requirements in respect of scope of major items of work:

4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (plant layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations / floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities. Drawings and Schedules prepared by the Contractor from time to time, as detailed designs are developed, shall be submitted for Owner's / Consultant's

approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.

4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-contractors.

4.06.03 Review of sub-contractor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.

4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope, Terminal Points & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.

4.06.05 Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the power plant.

4.06.06 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.

4.06.07 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support engineering.

4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.

4.06.09 Certification and submission of final as-built drawings for all areas.

4.06.10 Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.

4.06.11 All erection and assembly drawings which may be required at site.

4.06.12 For all bought out item packages, the Contractor shall provide complete material / component list along with detail specification, drawings, component part no. etc. during detail engineering stage prior to final approval. Such approved drawing/document shall be made available at site in adequate number prior to commencement of work. Moreover, such document/drawing shall be provided in soft form (CD)

4.06.13 Preparation of necessary documentation, design calculations etc. required for submission to statutory authorities like IBR, Chief Electric Inspector, Factory Inspector etc.

5.00.00 **OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS**

5.01.00 The Contractor shall provide at least six (6) months before the time of commissioning and before taking over of the plant and equipment, all necessary maintenance manuals and operating instructions. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies as per distribution schedule (Annexure-1).

5.02.00 The information provided, which shall be contained in loose leaf stiff backed covers, shall include :

a) A complete inventory of all main items of plant, with identification details.

b) Service manuals for all plant and equipment giving full descriptions of the main items and auxiliary items such as power packs, hydraulic equipment, actuators, lubricating pumps, etc.

c) A separate electrical manual covering items such as switchgear, cabling, instrumentation, controls, cabling layouts and wiring diagrams.

d) A schedule of recommendations for routine maintenance of all electrical and mechanical equipment, recommended inspection point, information on detection, cause and rectifications of troubles & faults.

e) A lubrication schedule with all necessary drawings diagrams to identify the lubrication points.

f) Manufacturer's literature.

5.03.00 The instruction manual shall be subject to the approval of Owner.

6.00.00 **PLANT HANDBOOK**

The Contractor shall submit to the Engineer, a preliminary plant handbook preferably in A-4 size sheets which shall contain the design and performance data of various plant, equipment and systems covering the complete project including single line flow diagrams, within twenty four (24) months from the date of his acceptance of the Letter of Intent. The final plant handbook complete in all respects shall be submitted by the Contractor six (6) months before start-up and commissioning activities. The plant handbook shall be submitted as per distribution schedule.

7.00.00 **CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE**

7.01.00 Within fifteen (15) days to one month of issue of Letter of Intent (LOI) by the Owner, the Contractor shall furnish a schedule of drawings and design

document to be submitted by him to the Owner/Engineer indicating dates against each document.

The documents shall be divided into two categories : a) for approval and b) for information/further engineering and co-ordination by the Owner.

In preparing this schedule, the Contractor shall allow two (2) weeks from date of receipt for review and comments by the Owner/Engineer for each submission of a document.

This document submission schedule shall require approval by the Owner/ Engineer.

7.02.00 All contract documents shall be marked, without fail, with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

7.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval / information of the Owner/Engineer.

7.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Engineer:

a) List of sub-vendors (from Owner only)

b) System scheme and instrumentation diagrams

c) Design basis justifying selection of equipment & process parameters where not specified in the Contract

d) Equipment data sheets and general arrangement drawings

e) Materials of construction

f) Layout drawings.

g) Operation logic diagrams.

h) Typical control circuit.

i) Drawings of Instrumentation and control.

7.05.00 Unless specified otherwise, the following categories of documents/ drawings would be treated for information/further engineering by the Owner/Engineer. The Contractor shall, however, incorporate all additional information and clarifications in these documents / drawings as and when desired by the Owner/Engineer.

a) Equipment foundation drawings.

b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.

c) Predicted performance curves of equipment.

d) Various bills of quantity, schedules etc.

e) Piping fabrication drawings, isometrics etc.

f) Panel wiring diagrams.

g) Instruction/Operation manuals.

h) Service manuals and trouble shooting guide for C & I system including field instruments.

i) Cable schedule and interconnection chart.

j) Drive/feederwise control scheme showing all external interfaces.

In essence, the Contractor is solely responsible for corrections and adequacy of design & engineering for documents under this category.

7.06.00 Upon review, the Owner/Engineer shall put his remarks and one of the following action stamps on the drawing/document:

a) A - Drawing submitted as approved, proceed with fabrication

b) B - Drawing approved subject to comments noted, proceed with fabrication, considering our comments. Correct as necessary and resubmit for record.

c) C - See attached memo.

d) D - Correct your original drawing incorporating our comments and resubmit for approval.

e) E - Information furnished is noted.

f) F - Prints not enclosed

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Engineer. For action stamp in category (b), further review by Owner/Engineer would not be necessary provided the Contractor agrees & incorporates the comments made on the document.

Except for action stamp under category (c) & (d), the Contractor can proceed with manufacturing and other sequential activities for those areas of a drawing/document which do not have any review comment by the Owner/ Engineer.

The Owner/Engineer may accord approval in category (c) or (d) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Contractor shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds. Approval of contract documents by the Owner/ Engineer shall not relieve the Contractor of his responsibility for any errors and fulfillment of contract requirements.

The Contractor's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Owner/Engineer.

7.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

7.08.00 For review by the Consulting Engineer, the Contractor shall furnish soft copies of drawings & documents and three (3) prints of each drawing/ document. Two (2) prints of such submission shall also be sent to the Owner. After review, comment/approval will be sent to the Contractor. Upon action under category (a) or (e), the Contractor shall directly distribute the documents to the various offices of the Owner and other agencies in number of copies as specified in the contract document. Such distribution copies shall be marked with the reference and date of the letter by which the Owner/ Engineer has accorded his final approval. Penal action shall be taken against the Contractor for any unauthorised revision in the drawings so distributed from the drawings approved by the Owner/Engineer. The contractor shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

7.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail.

7.10.00 For details of documentation for Civil, Structural and Architectural works, VII-A, VII-B and VII-C may be referred.

8.00.00 TENDER STAGE DOCUMENT SUBMISSION

8.01.00 The Bidder shall submit along with his bid all documents/drawings as requested in respective specifications. The documents shall include but not be limited to the following :

a) All Bid proposal sheets duly filled up.

b) Detailed experience list and financial resources of the prime bidder his collaborators/associates in this bid as well as the sub-vendors proposed.

c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.

d) List of terminal points of the package offered together with quality and quantity of various input (i.e. water, air, electricity etc.) as required from the Owner at such interfaces.

e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.

f) L-1 network indicating target dates for intermediate milestones and final commissioning of equipment supplied; This network shall be supplemented by a detailed write-up on proposal procedure of project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

g) List of suppliers for all bought out items.

DISTRIBUTION SCHEDULE

S. No	Description	TSGENCO								CONSULTANT			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS		
A	**Letter Of Intent or Contract Documents**	1	1	1	S	1	2	2	1	1	1	1	2	
B	**Vendor Drawings**													
1.	Preliminary	1	1	1	2	1	1	2	2	12	1	-	S	
2.	Return preliminary with comments	-	-	1	2	1	1	1	1	S	1	-	1	
3.	Final and any revision thereof													
	a. Civil	1	1	6+1T	1	1	6+1T	1	-	2+1T	1	1	S	
	b. E&M	1	1	1	6+1T	1	1	6+1T	1	2+1T	1	1	S	
C.	**Design Drawings**													
1.	Preliminary													
	a. Civil	1	1	2	1	1	2	1	1	4	1	1	S	
	b. E&M	1	1	1	2	1	1	2	1	4	1	1	S	
2.	Released for construction													
	a. Civil	1	1	2	1	1	6	1	1	1	1	2	S	
	b. E&M	1	1	1	1	2	1	6	1	1	1	2	S	
3.	Return marked 'As built'													
	a. Civil	-	-	1	-	-	1	-	-	1	1	S	1	
	b. E&M	-	-	-	1	-	-	1	1	1	1	S	1	
4.	As built drawings													
	a. Civil	-	-	1+1T	-	2+1T	5+1T	-	1	1+1T	-	1	S	
	b. E&M	-	-	1	2+1T	2+1T	-	5+1T	1+1T	1+1T	-	1	S	

S. No	Description	TSGENCO								CONSULTANT			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS		
D	Progress Report Monthly													
1.	Equipment vendor	1	1	1	2	1	1	2	1	1	1	1	S	
2.	M/s DCPL, Kolkata	1	1	2	2	1	1	2	1	S	1	1	Nil	
E	Test & Inspection Reports													
1.	Equipment manufacturer													
	a. Civil	1	1	1	2	1	1	1	-	11	1	1	S	
s	b. E&M	1	1	-	2	1	-	1	1	11	1	1	S	
2.	M/s DCPL, Kolkata	1	1	-	2	1	-	1	1	S	-	1	-	
F	Instruction Manuals/Data Books													
1.	Equipment manufacturer													
	a. Civil	1	1	1+1T	1	1	6+1T	1	1	2+1T	1	1	S	
	b. E&M	1	1	-	3+1T	1	-	6+1T	2	3+1T	1	1	S	
2.	M/s DCPL, Kolkata	1	1	-	10+1T	1	-	15+1T	-	S	1	1	Nil	
G	M/s DCPL, Kolkata Criteria	1	1	1	8+1T	1	1	2	1	1	1	1	S	
H	Design Calculations	1	1	1	8+1T	1	1	2	1	1	1	1	S	
I	Final consulting Engineering Report	1	1	1	10	1	1	2	1	S	1	1	Nil	

S – Source, T – Transparency & Soft Copy on CD,

TSGENCO : Telangana State Power Generation Corporation Limited

Director, Projects, Hyd : Director/ Projects, TSGENCO, Vidyut Soudha, Hyderabad – 500 082

a) Bidder shall apply in writing to Owner for handing over of the complete Control & Instrumentation System after successful demonstration of tests as specified up to "Availability Guarantee Test".

b) Owner shall take over charge of the C&I system subject to fulfillment of the conditions enumerated hereunder :

i) Site check-list prepared by Owner are fruitfully attended by Bidder and certified by Owner.

ii) Operation/ Instruction manuals are updated to incorporate changes made up to Availability Test Run.

iii) Drawings/ sketches are submitted as per Contract, on as- built basis.

iv) Close loop controls, Binary & Sequential controls should be working on auto and interlocks are demonstrated to be functional.

v) Equipment and system supplied by Bidder are in working condition.

vi) Short supply items, as per Contract, are refurnished by Bidder.

vii) The above conditions are in addition to fulfillment of any/all other contractual obligations of Bidder towards Owner. Partial handing-over of systems /equipments shall not be permissible, except if desired so by Owner in special cases.

11.00.00 TRAINING OF PERSONNEL

11.01.00 Bidder shall include in the proposal training of Owner's personnel of different categories for operation, maintenance and troubleshooting of the supplied equipment. Training courses shall be conducted by experienced personnel of Bidder. Course participants shall receive individual copies of technical manuals at the time the course is conducted. Upon completion of each course, training manuals shall be property of Owner. Bidder shall supply all updates and revisions to the manuals.

11.02.00 Training shall be provided to operating, programming and maintenance personnel. The training shall be conducted at original equipment designer / manufacturer's works. While the exact content and duration of such training shall be guided by Bidder's experience , following gives the basic and minimum requirement of operation and mainteanance , troubleshooting training from Owner's point of view.

11.03.00 PLANT OPEARTION TRAINING

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
12	Control Engineer	Main plant through DDCMIS OS	8 weeks each
16	Control Engineer	PADO System Usage	2 weeks each

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
12	Control Engineer	Each type of utility plant through PLC OS	4 weeks each

11.04.00 SYSTEM MAINTENANCE TRAINING

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
6	C&I Engineer	DCS Hardware and Software.	8 weeks each
6	C&I Engineer	PLC system Hardware and Software.	2 weeks each
8	Maintenance Engineer	CMIMS System Functioning and Maintenance.	2 weeks each
2	C&I Engineer	MIS Hardware and Software	1 week each
2	C&I Engineer	HART Management System	1 week each
2	C&I Engineer	SWAS Hardware and Software	1 week each
2	C&I Engineer	CEMS Hardware and Software	1 week each
2	C&I Engineer	Ambient Air Quality and Monitoring System Hardware and Software	1 week each
2	C&I Engineer	CCTV Hardware and Software	1 week each
2	C&I Engineer	Plant Telephone And PA System	1 week each
2	C&I Engineer	PADO Hardware and Software	1 week each

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
4	C&I Engineer	RMCMAS Hardware and Software	2 weeks each
4	C&I Engineer	All other Instruments and Systems	Adequate Training

11.05.00 TRAINING ON TG SYSTEM

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
4	C&I Engineer	Turbine Governing Control and protection system Hardware and Software.	2 weeks each
4	C&I Engineer	Turbine Supervisory Instruments	2 weeks each
4	C&I Engineer	TDBFP Governing and protection system	1 week each
4	C&I Engineer	All other Instruments and Systems	Adequate Training

11.06.00 TRAINING ON SG SYSTEM

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
4	C&I Engineer	BMS / Boiler protection system Hardware and Software.	2 weeks each
4	C&I Engineer	Furnace Flame monitoring and Analysis System Hardware and Software.	1 week each

NO.OF PERSONNEL	CATEGORY OF PERSONNEL	SUBJECT	DURATION
4	C&I Engineer	Boiler tube leak detection System	1 week each
4	C&I Engineer	All other Instruments and Systems	Adequate Training

11.07.00 Training for the Engineers & operators shall be based on direct hands-on use of the offered system supported by lectures. Bidder shall train Owner's personnel in the programming and maintenance of the equipment to the extent that Owner's personnel can make corrections and changes to the system and maintain the systems hardware independently. Bidder shall include in his proposal a detailed description of the training course proposed by him (class-room lecture, audio-visual presentation, hands-on). If Bidder conducts Owner's training on regular periodic basis, a printed brochure of such program may be enclosed for reference.

11.08.00 Bidder shall provide all additional training deemed necessary by Owner , if there are modifications to Bidder's system and software after completion of the regular training period.

SECTION: I

SUB-SECTION: C 2C

CUSTOMER SPECIFICATION-PAINTING SPECIFICATION

TECHNICAL SPECIFICATION

FOR

PROTECTIVE LINING AND PAINTING

SECTION-XIII

TECHNICAL SPECIFICATION

FOR

PROTECTIVE LINING AND PAINTING

C O N T E N T S

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SECTION-XIII

TECHNICAL SPECIFICATION

FOR

PROTECTIVE LINING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Package.

1.02.00 The Bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The Bidder shall follow relevant Indian and International Standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

a) SSPC SP 10 / NACE 2 /	:	Near White Blast Cleaning
b) SSPC PA 2	:	Measurement of dry film Coating Thickness with magnetic gauges.
c) ASTM D 4541	:	Method for pull off strength using portable Adhesion Tester.
d) NACE RP 0274 – 2004	:	High-Voltage Electrical Inspection of Pipeline Coatings
e) NACE SP 0188 – 2006	:	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

f)	NACE RP 0169 – 2002	:	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
g)	AWWA C 210 – 2007	:	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
h)	IS 3589:2001 Annexure B	:	Steel Pipes for Water and Sewage Specification.
i)	AWWA C222-2000	:	Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.
j)	IS 13213 : 2000	:	Polyurethane Full Gloss Enamel (Two pack)

3.00.00 GENERAL REQUIREMENTS

3.01.00 The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2½ (near white metal) with sand blasting.

3.02.00 The contractor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to Owner/Consultant for approval.

3.03.00 The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) in support of the paint/primer materials to be used shall conform to the specification requirement.

3.04.00 The contractor shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) shall also be submitted prior to commencement of supply of material and field application.

3.05.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.

3.06.00 Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM D 4541.

3.07.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.

3.08.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.

3.09.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a Purchaser approved method shall be adopted.

3.10.00 The colour scheme of the entire Plant, covered under this specification shall be approved by the Purchaser in advance before application.

3.11.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by Purchaser.

3.12.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti corrosive painting.

3.13.00 For vessels / tanks requiring lining and epoxy painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

3.14.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.

3.15.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).

3.16.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.

3.17.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.

3.18.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.

3.19.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER

4.01.00 After erection at site, the outside surfaces of all equipment having a shop coat shall be given further priming coat and finished coats of paint as detailed in following clauses. However, if the painting system is such that the shop coat and primer coat to be applied at site are not compatible, then shop coat has to be removed from the surface of equipment before application of primer coat with prior blasting.

All factory finished paints shall be touched up at site as required.

All uninsulated piping shall be finished with final paintings after use of proper wash primer and primer. Aluminium sheet jacketed piping need not be painted. Colour bands of Purchaser's approved shade shall however be applied on jacketed piping near walls or partitions, at all junctions, near valves and all other places as instructed by the Purchaser. All structures shall be painted with approved paint.

4.02.00 Surface Preparation

4.02.01 Unless mentioned otherwise, all rust and mill scale shall be removed by blasting to Sa 2-1/2 Swiss Standard before applying the primer.

4.02.02 Special care shall be taken to remove grease and oil by means of suitable solvents like Trichloroethylene or Carbon Tetrachloride.

4.02.03 The minimum degree of surface preparations for all equipment, piping, fittings, valves, structures etc. shall be "Near White" according to Steel Structure, Painting Council-SSPC-SP-10 before application of any primer/paint.

4.03.00 Painting

4.03.01 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc. to be installed indoor shall be as follows :

a) Surface preparation shall be done either manually or by any other approved method.

b) Primer Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based zinc phosphate.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber paint of approved shade and colour with glossy finish.

e) Total DFT of paint system shall not be less than 150 microns.

4.03.02 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc to be installed **outdoor** shall be as follows :

a) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard.

b) Primer Coat shall consist of one coat (minimum DFT of 100 microns) of epoxy resin based zinc phosphate primer.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 100 microns) epoxy resin based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 75 microns) of epoxy paint of approved shade and colour with glossy finish. Additional one coat (minimum DFT of 25 microns) of Finish Coat of polyurethane shall be provided.

e) Total DFT of paint system shall not be less than 300 microns.

4.03.03 Specification for application of paints for external surfaces protection of steel pipes and fittings which are **buried underground / laid inside a hume pipe & or submerged Under Water and laid under Pipe Trenches** (in road/rail/pipe or trench crossings) shall be as follows :

External surface of the pipe, fittings, specialties etc. handling raw water/clarified water/filter water shall be painted with one coat of two part chemically cured polyurethane primer of min 50 micron dry film thickness followed by three or maximum four coats of two part solvent less polyurethane to build up coating of dry film thickness of 2000 micron including primer coat.

4.03.04 Specification for application of paints for **internal surface protection of large diameter pipes** (sizes above 600 mm NB and above) if any, shall be as follows :

a) All Internal surfaces of steel pipes, fittings, specialties etc. buried underground or located within pipe trenches shall be given epoxy coating to protect them from (except for drinking water service, where the compatible painting shall be so selected to meet relevant quality standards) corrosion.

b) Internal surface of the pipe should be coated with one coat of two part epoxy primer with not less than 50 micron DFT (dry film thickness) followed by two part polyamide cured solvent less epoxy.

c) The minimum dry film thickness (DFT) of internal lining shall be 600 micron.

4.03.05 Specification for application of paints for protection of **internal surfaces of DM Water Storage Tank(s)** shall be as follows :

a) Primer - One coat of epoxy primer containing high level of Zinc Phosphate anticorrosive pigment. Total Dry Film Thickness (DFT) of primer shall not be less than 125 microns.

b) Finish Paint - Three (3) coats Polyamine HB Epoxy Paint. Total Dry Film Thickness (DFT) of finish paint shall not be less than 125 microns per coat.

c) Total thickness of primer and paint should not be less than 500 microns.

4.03.06 All motors, local push button stations, cable racks, structures used for supports etc. are to be painted with acid proof paint.

4.03.07 The following surfaces shall not be painted - stainless steel, galvanized steel, aluminum, copper, brass, bronze and other nonferrous materials.

4.03.08 No painting or filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed.

4.03.09 All machined surfaces shall have two (2) coats of water repellant grease after thorough cleaning.

5.00.00 COATING PROCEDURE AND APPLICATION

5.01.00 Surface Preparation :

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 / NACE 2 / Sa2½ of ISO 8501 (near white metal)

a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.

b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3°C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.02.00 Application of Epoxy Coating

a) Coating shall be applied when

i) When the pipe surface temperature shall be atleast 3°C above dew point temperature.
ii) The temperature of mixed coating material and the pipe at the time of application shall not be lower than 10°C or greater that 50°C.

b) Material preparation shall be in accordance with manufacturer's recommendations.

c) Application of epoxy coating system :

The epoxy coating system shall be applied as per recommendation of the manufacturer and shall be applied by airless spray / plural component spray machine. For more than one coat, the second shall be applied with the time limits as recommended by the manufacturer.

5.03.00 Application of PU Coating

a) PU coating shall be applied when the pipe surface temperature atleast 3°C above dew point temperature (when R.H is more than 85%).

b) Material preparation and application shall be done as per manufacturer recommendation.

6.00.00 TEST REQUIREMENTS :

6.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating : Coating thickness shall be in the range of ±20% and as per SSPC PA 2.

6.01.01 Apparatus / Instrument:-

The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

6.01.02 Procedures:-

a) Number of measurements:
For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).

b) If the structure is less than 300 square feet, each 100 square feet should be measured.

c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.

d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet

e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness. Area measurement must be within specified range.

6.02.00 Electrical Inspection (Holiday) Test

6.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

6.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.

6.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing Voltage $V = 7900 \sqrt{T} \pm 10$ percent where T is the average coating thickness in mm.

6.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

6.03.00 Adhesion Pull off Test :

After holiday the coated surface is subjected to adhesion pull off test as per ASTMD 4541.

6.03.01 Apparatus / Instrument: Adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling “Jaw” at the bottom and also dollies.

6.03.02 Prepare the test surface :

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.

6.03.03 Prepare Dolly (Test Pull Stub) :

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

6.03.04 Select an adhesive:

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

6.03.05 Attach the dolly to the surface.

a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.

b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.

c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.

d) Push the dolly inward against the surface, then apply tape across the head of the dolly.

6.03.06 Adhesion Test Procedure

a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.

b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.

c) Slide the dragging indicator pin on the black column to zero by pushing it downward.

d) Firmly hold the base of the instrument in one hand and rotate the handwheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/MPa/Kg/cm^2 required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm^2 of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

6.04.00 Coating Repair

Defective Coating shall be repaired in accordance with the following subsections.

6.04.01 Surface Preparation:

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

6.04.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

6.04.03 Coating Application :

The coating system shall be applied to the prepared areas in accordance with procedure.

6.04.04 Repair Inspection :

Repaired portion shall be electrically inspected using a holiday detector.

6.05.00 Welded Field Joints

6.05.01 Preparation :

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

6.05.02 Electrical Inspection :

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

7.00.00 INFORMATION/DATA REQUIRED

The Bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. and also unit rates for application of each type of paint along with supply shall be furnished.

SECTION: I

SUB-SECTION: C3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA STATE, INDIA

5x800 MW YADADRI TPS

AIR CONDITIONING SYSTEM TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT,
NOIDA, U.P., INDIA

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NOTE: THE REQUIREMENTS MENTIONED IN SECTION-I SHALL PREVAILAND GOVERN IN CASE OF CONFLICT BETWEEN THE SAME AND THE CORRESPONDING REQUIREMENTS MENTIONED IN THE DESCRIPTIVE PORTION IN SECTION-II.

SPECIFIC TECHNICAL REQUIREMENTS

FOR LV MOTORS (ELECTRICAL)

SECTION-I

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipment's.
d) Electrical load requirement for AIR CONDITIONING SYSTEM.
e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc. shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
h) Motor shall meet minimum requirement of motor specification.
i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
j) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor" Annexure - I.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

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

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc., is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures:

a) Electrical scope between BHEL & vendor (Annexure –I)
b) Technical specification for motors.
c) Datasheets for motors.
d) Electrical Load data format (Annexure –II)
e) BHEL cable listing format (Annexure –III)
f) Quality plan for motors.

BASIC TECHNICAL FEATURES FOR LT MOTORS

(FOR BHEL–PEM SCOPE PACKAGES)

CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, NALGONDA
OWNER'S CONSULTANT:	TATA CONSULTING ENGINEERS LTD BANGLORE INDIA
JOB NO. 417 STATUS CONTRACT DISTRIBUTION	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

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DEPT CODE		NAME	SIGN	DATE
I	DRN	HC	s.d.	07.12.17
	DESN	HC	s.d.	07.12.17
	CHD	AS	s.d.	07.12.17
	APPD	PD	s.d.	07.12.17

REV.	DATE	ALTD	CHD	APPD	REMARKS
02	16.08.2018	HC	AS	PD	REVISED IN LINE WITH CUSTOMER COMMENTS DT. 13.08.2018
01					REVISED IN LINE WITH CUSTOMER COMMENTS DT. 19.04.2018

TITLE: BASIC TECHNICAL FEATURES FOR LT MOTORS

DEPT. / SIGN / SCALE

DRAWING NO. PE–DC–417–565–E003

SHEET 1 OF 7 REV. 02

1.0 This document covers the basic technical features of low tension (LT) squirrel cage induction AC motors employed for driving auxiliaries of BHEL-PEM scope packages in **5 x 800 MW YADRADRI TPS.**

2.0 CODES AND STANDARDS

All motors shall conform to the latest applicable standards as listed below;

1) Three phase induction motors: IS: 12615, IEC: 60034
2) Single phase AC motors: IS: 996, IEC: 60034
3) Crane duty motors: IS: 3177, IEC: 60034
4) Energy Efficient motors: IS 12615 or IEC: 60034-30 with Efficiency class IE3

3.0 DESIGN REQUIREMENTS

3.1 **Service Conditions**

The motors will be installed in hot, humid and tropical atmosphere highly polluted at places with coal dust and/or fly ash. For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature.
The design ambient temperature shall be 50 deg C.

3.2 Supply system and rated voltage of motors

KW rating	Supply system	Rated voltage of motor
Upto 0.2 kW	240V/415 V	240V415 V
Above 0.2 kW & up to 175kW	415 V	415 V

3.2.1 Supply voltage & variations shall be as follows:-

Voltage variation (AC Supply): (+/-) 10%
Frequency variation : (+) 3% to (-) 5%
Combined V & F variation : 10% (sum of absolute values)

During starting of large motor, the voltage may dr op to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running s hall successfully ride over such period without affecting system performance.

3.2.2 Motors shall be capable of running continuously at rated output for each of the conditions specified.

3.3 **Motor Rating**

All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity. LT motor rating at 50 degree C shall have at least 15% margin over the input power requirement of the driven equipment at rated duty point unless stated otherwise in driven equipment specification. The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

3.4 **Starting Requirements**

3.4.1 Motor shall start smoothly and rapidly. Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinat ed with the requirements of driven equipment. The

accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.4.2 Motors shall be capable of starting and accelera ting the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequenc y under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value of 85 (eighty five) percent rated voltage.

3.4.3 Continuous duty LT motors up to 175 KW Output rati ng (at 50 deg. C ambient temperature), shall be Premium efficiency (IE3) as per IEC: 60034-30/ IS: 12615 and the locked rotor current of motors shall as per IS 12615.
However, as per system requirement drives ra ted in the range of 160-210 KW may be considered in either 415V or 3.3 KV

3.4.4 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with shaft rotating at 125% rated speed in reverse direction. The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage.

3.4.5 The following frequency of starts shall apply

i) Three cold starts in succession with the motor being initially at a temperature not exceeding the ambient temperature.

ii) Two hot starts in succession with the motor being initially at a tem perature not exceeding the rated load temperature.

iii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature (not to be repeated in the second successive hour)

3.4.6 Locked motor withstand time of hot motors at 110% rated voltage shall be as follows:

a) For motors with starting time upto 20 sec.

- at least 3 sec. more than starting time.

b) For motor with starting time above 20 secs but not exceeding 45 secs.

- at least 5.0 sec. more than starting time.

c) For motors with starting time above 45 secs.

- at least 10%. more than starting time.

The starting time of the motor referred above is at minimum permissible voltage. Wherever the above requirements are not complied with, speed switches of approved make & type shall be provided to bypass the locked rotor protection for a pre-selected time during starting of motors. The speed switches shall have one NO & one NC contacts having maximum interrupting capacity of 5 Amps at 240V AC and 0.25 amps at 220 V DC.
Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

3.5 **Running Requirements**

3.5.1 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given above.

3.5.2 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

3.5.3 The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.6 **Stress during bus Transfer**

3.6.1 The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

3.6.2 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

4.0 SPECIFIC REQUIREMENTS

4.1 **Enclosure**

All motor enclosures for outdoor, semi-outdoor & indoor application shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction with canopy. For hazardous area approved type of increased safety enclosure shall be furnished.

4.2 **Cooling**

4.2.1 The motor shall be self-ventilated type, either totally enclosed fan cooled IC 411(TEFC), totally enclosed tube ventilated IC 511(TETV) or closed air circuit air- cooled IC 611(CACA).

4.3 **Winding and Insulation**

All insulated winding shall be of copper. All motors shall have class F insulation but limited to class B temperature rise. Windings shall be impregnated to make them non-hygroscopic and oil resistant.

Tropical Protection

All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

All fittings and hardware shall be corrosion resistant.

4.4 **Bearings**

4.4.1 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be rated for minimum service life of 40,000Hrs.

4.4.2 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.

4.4.3 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

4.4.4 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.

4.4.5 Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication. LT motors 15kW and above shall be provided with external greasing arrangement.

4.4.6 Oiled bearing shall have an integral self-cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.

4.4.7 Forced lubricated or water cooled bearing shall be used as per requirement.

4.4.8 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.

4.4.9 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.

4.5 **Noise & Vibration**

4.5.1 For 415V motors, maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm.

4.5.2 The noise level shall not exceed 85db (A) at 1.5 meters from the motor.

4.6 **Motor Terminal Box**

4.6.1 Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation

4.6.2 Terminal box shall be capable of being turned 360 deg in steps of 90 Deg. for LT motors unless otherwise approved.

4.6.3 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.

4.6.4 The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.

4.6.5 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

4.6.6 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

4.6.7 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

4.6.8 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.

4.6.9 The gland plate for single core cable shall be non-magnetic type. A suitable cable adopter box shall be provided if the cable size does not allow the direct termination in the main TB.

4.6.10 Minimum clearances to be provided between phase to phase and phase to earth shall be as under-

Voltage Rating of Motor Minimum Ph-Ph & Ph-Earth clearance
0.415 kV : 25 mm

Note: In case it is not possible to maintain these clearances, the live parts shall be totally insulated from earth and other Phases. Adequate clearances shall be provided for cable connections.

4.7 **Grounding**

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.
The cable terminal box shall have a separate grounding pad.

4.8 **Rating Plate**

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate:

a) Temperature rise in Deg.C under rated condition and method of measurement.
b) Degree of protection.
c) Bearing identification no. and Type of lubrication, Quantity and frequency/ time interval
d) Location of insulated bearings.

5.0 ACCESSORIES

5.1 SPACE HEATERS

Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement. The space heater shall be rated 240 V, 1 Phase, 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle. The minimum cable size for space heater shall be 2.5 sq.mm copper cable.

5.2 DELETED

5.3 INDICATOR/ SWITCH

5.3.1 Dial type local indicator with alarm contacts shall be provided for the following:

Hot and cold air temperature of the closed air circuit for CACA motor.

5.3.2 Alarm switch contact rating shall be minimum 2.0 A at 220V D.C. and 10A at 240V A.C.

5.4 ACCESSORY TERMINAL BOX

5.4.1 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.

5.4.2 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit owner's cable connections.

DRAIN PLUG

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

5.5 LIFTING PROVISIONS

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

5.6 DOWEL PINS

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

7.0 PAINTING

Colour scheme for motors shall be shade 631 of IS-5.

8.0 TESTING

8.1 Type Tests

For LT Motors, type test reports for type te sts as per IS: 12615/ IEC: 60034 conducted on equipment similar to those proposed to be supplied sha ll be submitted. The type Test should have been conducted within last 5 years from enquiry date.

8.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 12615/ IEC: 60034 in the presence of customer or customer representative.

9.0 **Variable Frequency Drive motor details:**

i) The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
ii) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
iii) The Motor shall be designed to operate continuously at any speed over the range 20-100 % of rated speed.
iv) The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
v) Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value in motor specifications.
vi) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
vii) The motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800-4.
viii) The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: AIR CONDITIONING SYSTEM

PROJECT: 5 x 800 MW YADADRI TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: AIR CONDITIONING SYSTEM

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
15	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1 2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20 21	
ANNEXURE-II																				

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	417	ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE	5X800MW YADADRI TPS	NAME		DATA FILLED UP ON	
	SYSTEM	Air Conditioning System	SIGN.		DATA ENTERED ON	
	DEPTT. / SECTION	MAUX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

1.0	Design ambient temperature	:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor	:	175 KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection	:	IP55
5.0	Details of supply system		
	a) Rated voltage (with variation)	:	240V, 415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal box	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
6.0	Class of insulation	:	Class ‘F’,with temp rise limited to class B.
7.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
8.0	Power cables data	:	Shall be given during detailed engg.
9.0	Earth Conductor Size & Material	:	Shall be given during detailed engg.
10.0	Space heater supply (30KW & ABOVE)	:	240 V, 1Φ , 50 Hz
11.0	Rating up to which Single phase motor	:	Acceptable below 0.20 Kw
12.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL
13.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS-12615
	b) Permissible tolerance, if any	:	As per IS-12615
14.0	Terminal box	:	Suitable to rotate at 90 degrees
15.0	Paint shade	:	Shade 631 of IS-5

	TITLE MOTOR DATA SHEET – C 5 X 800 MW YADADRI TPS	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

CABLE SCHEDULE FORMAT

ANNEXURE III

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

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)

(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)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

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

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
		PROJECT:		PO NO.:	
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-		
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-		
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-		HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-		

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✔	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

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ENGINEERING			QUALITY		
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Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 3 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180º	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

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					M	C/N				D	M	C	N	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG./ SPECS.	LOG BOOK		P	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	

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					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ ASTM-E165	MANUFACTURER'S STD./ APPROVED DATASHEET.	LOG BOOK	✔	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	THREE DIPS TO BE GIVEN

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1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		4.DURATION	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
		3.HV	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S DWG.	LOG BOOK		P	-	-	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✔	P	V	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	

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					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✔	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325/IS-12615/IEC-60034 PART-1/IS: 12802	TC	✔	P	V$	-	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TC	✔	P	V$	-	$ NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✔	P	V$	-	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✔	P	W$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

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					M	C/N				D	M	C	N	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✔	P	W	-	(#): REFER NOTE-8

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, 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 PURCHASE GROUP FOR REVIEW.

6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE 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: DOCUMENT

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		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (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	D	M	C	N	
					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					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	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 55KW (LV (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 KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

TATA CONSULTING ENGINEERS LIMITED
VENDOR DOCUMENT REVIEW STATUS

☑ A Drawing/Document approved as submitted. Proceed with fabrication/construction.
☐ B Drawing/Document approved subjected to comments noted. Proceed with fabrication/ construction considering our commnets.
☐ C Our comments are noted on this marked up print.
☐ D Our commnets are noted in memo attached to the forwarding transmittal letter No. .....Dated.....
☐ E Correct original of this drawing/document to reflect our comments and resubmit for approval.
☐ F Correct original of this drawing/document to reflect our comments and resubmit for records.
☐ G Drawings/Documents of this category are for information only and not for approval. Information furnished on the drawing/document is noted.
☐ H Drawing/Document reviewed against our previous comments and other revisions highlighted and identified by the vendor.
☐ I Drawing/Document returned without review.
☐ J Print not enclosed.

Approval conveyed herein neither relieves the Vendor/Contractor of his contractual obligations and his responsibilities for correctness of dimensions, materials of construction, weights, quantities, design details, assembly fits, performance requirements and conformity of the supplies with the Indian Statutory Laws as may be applicable, nor does it limit the purchaser's rights under the contract.

Reviewed by..PC.....Date.02.11.2018

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS,

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

JOB NO. 417
STATUS CONTRACT
DISTRIBUTION

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

COPY RIGHT AND CONFIDENTIAL
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
I	DRN	AV		17.07.18
	DESN	AV		17.07.18
	CHD	NNJ		17.07.18
	APPD	PD		17.07.18

REV.	DATE	ALTD	CHD	APPD

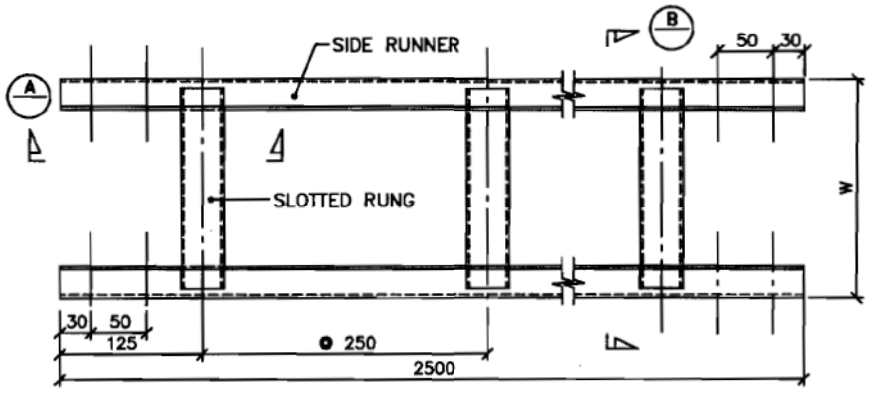
REV.	DATE	ALTD	CHD	APPD

TITLE: TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

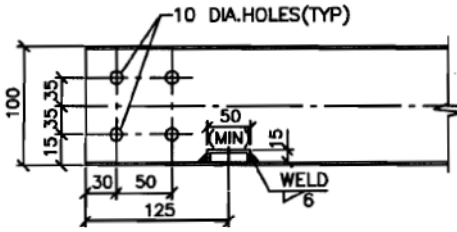
DEPT. SIGN | SCALE

DRAWING NO. PE-DG-417-507-E005

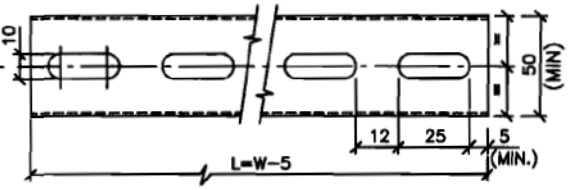
SHEET 1 OF 17 REV. 2



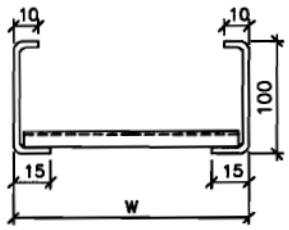
LADDER TYPE CABLE TRAY



SEC – (A)

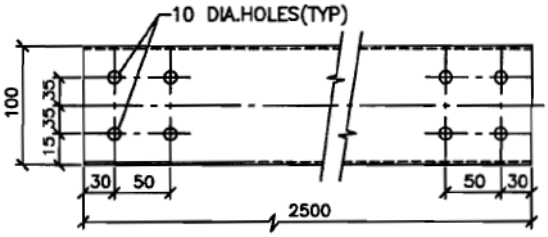


SLOTTED RUNG



SEC – (B) △1

W	300	450	600	150
L	295	445	595	145



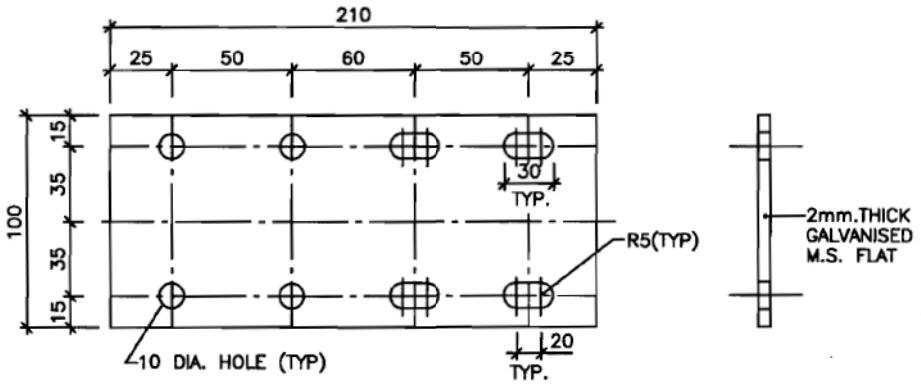
SIDE RUNNER

MATERIAL : M.S. SHEET 14 SWG.(2mm.THK.)
FINISH : HOT DIP GALVANISED

NOTE :-

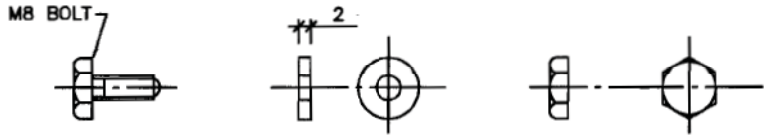
1. ALL DIMENSIONS ARE IN MM.

	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
		REV. 2 | SHT. 02 OF 17



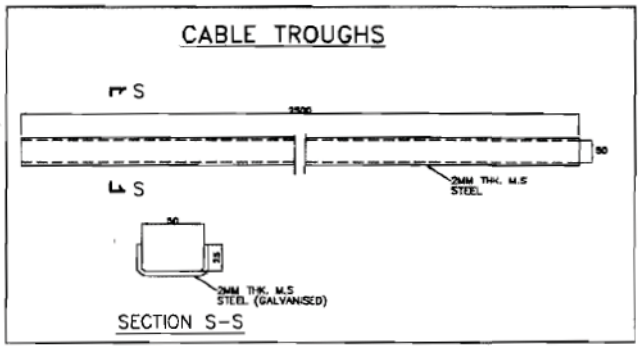
SIDE COUPLER PLATE

(TWO COUPLER PLATE FOR EACH JOINT) 1



M8 BOLT, WASHER & NUT

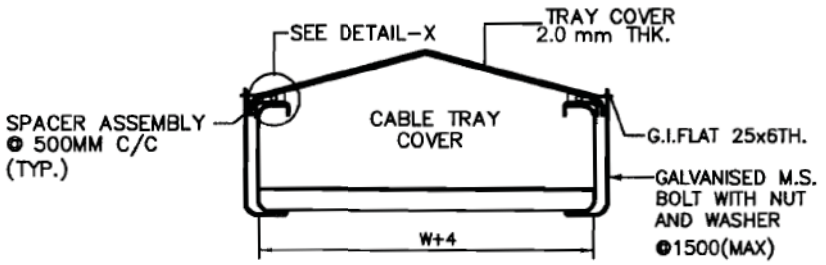
(FOR CABLE TRAY JOINT)



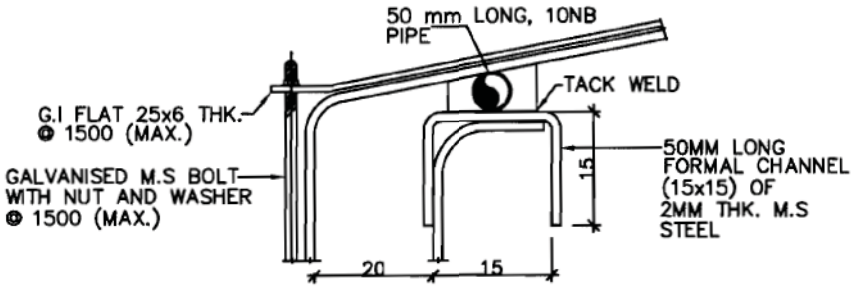
NOTE :-

1. ALL DIMENSIONS ARE IN MM.

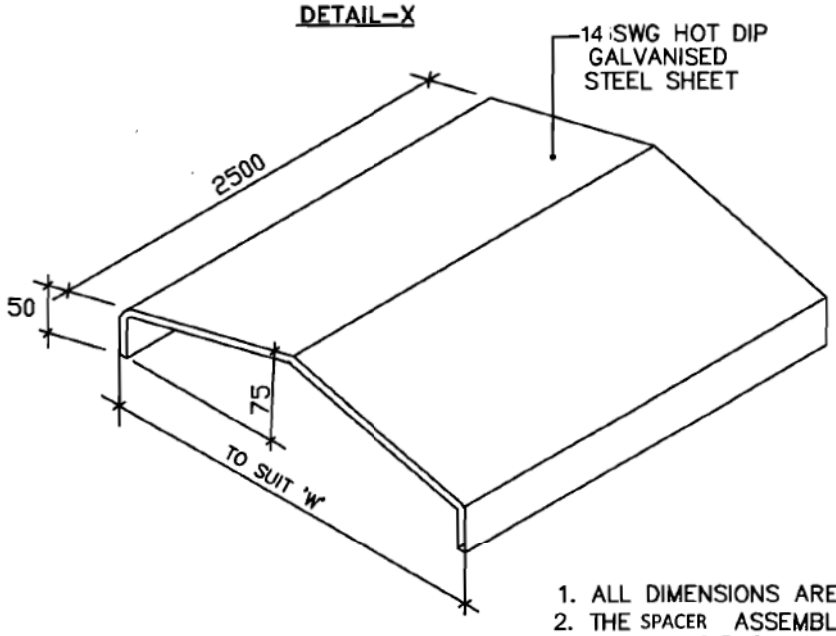
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
	REV. 2 SHT. 03 OF 17



COVER FIXING (TYP.)



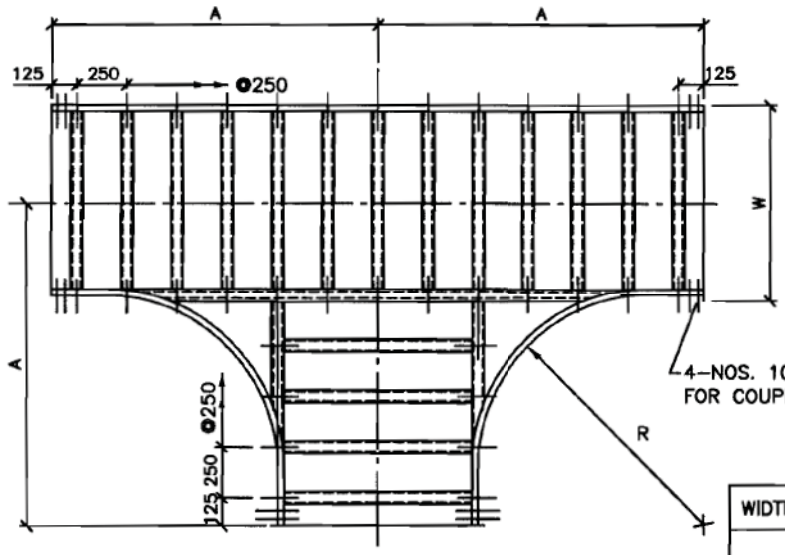
DETAIL-X



1. ALL DIMENSIONS ARE IN MM.
2. THE SPACER ASSEMBLY SHALL BE HOT DIP GALVANISED

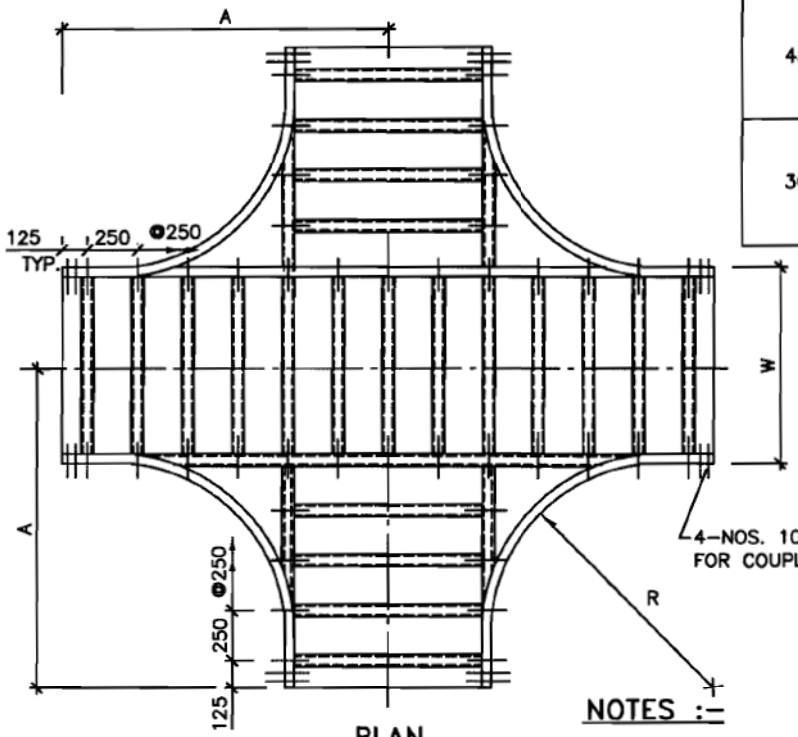
CABLE TRAY COVER

	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417[illegible]-507-E005
		REV. 2 SHT. 04 OF 17



PLAN
HORIZONTAL TEE

WIDTH (W)	RADIUS (R)	A
600	1050	1475
	600	1025
	450	875
	300	725
450	1050	1400
	600	950
	450	800
	300	650
300	1050	1325
	600	875
	450	725
	300	575

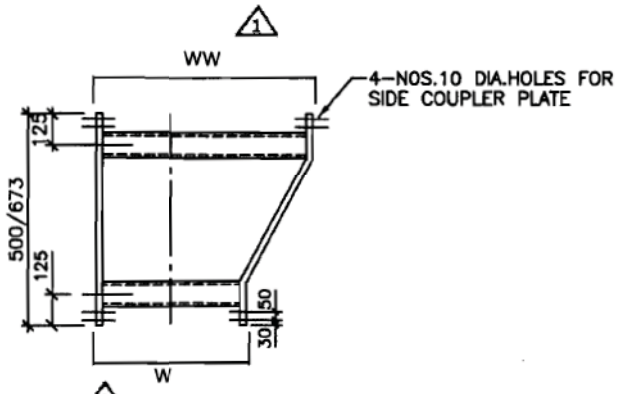


PLAN
HORIZONTAL CROSS

NOTES :–

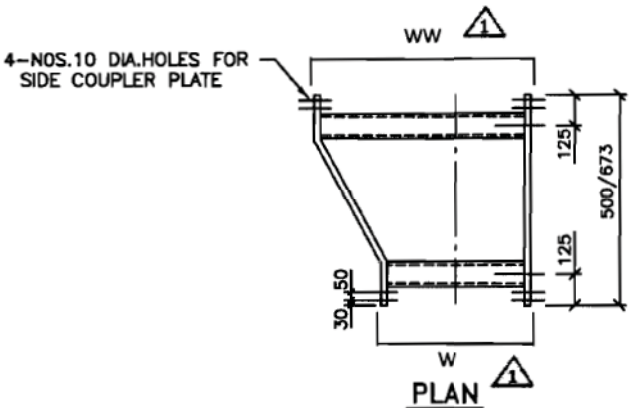
1. ALL DIMENSIONS ARE IN MM.
2. FOR MULTITIER CABLE TRAY, THE BENDING RADIUS AT THE BENDS SHALL BE SAME FOR ALL TRAYS AND THIS RADIUS SHALL BE AS PER THE RECOMMENDED BENDING RADIUS OF LARGEST CABLE IN THE ROUTE.

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE–DG–417 –507–E005
	REV. 2 SHT. 05 OF 17



1 PLAN

LEFT HAND REDUCER



PLAN

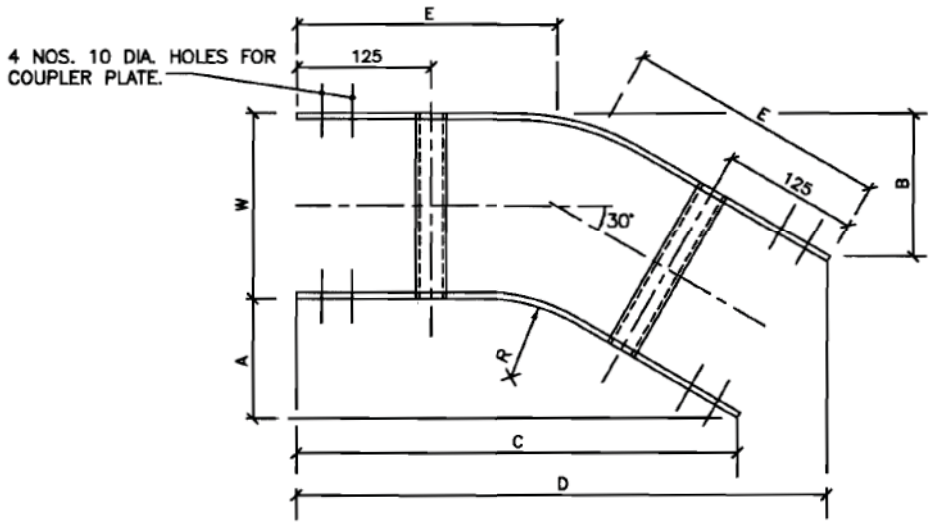
RIGHT HAND REDUCER

WIDTH	WW	600	600	450
	W	450	300	300

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
	REV. 2 SHT. 06 OF 17



PLAN
30° HORIZONTAL ELBOW

WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	205	285	755	1055	485
	600	145	225	530	830	365
	450	125	205	455	755	325
	300	105	185	380	680	285
450	1050	205	265	755	980	465
	600	145	205	530	755	345
	450	125	185	455	680	305
	300	105	165	380	605	265
300	1050	205	245	755	905	445
	600	145	185	530	680	325
	450	125	165	455	605	285
	300	105	145	380	530	245

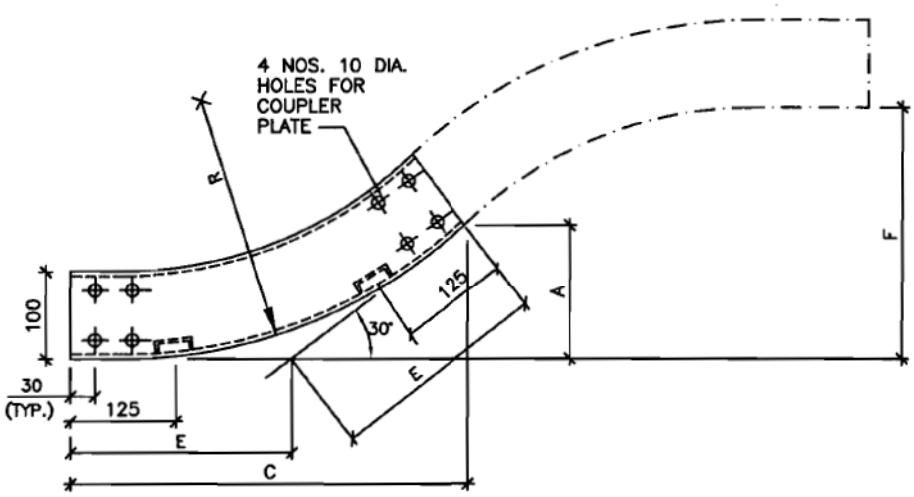
NOTE :-

1. ALL DIMENSIONS ARE IN MM.

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

DWG. NO.
PE-DG-417[illegible]-507-E005

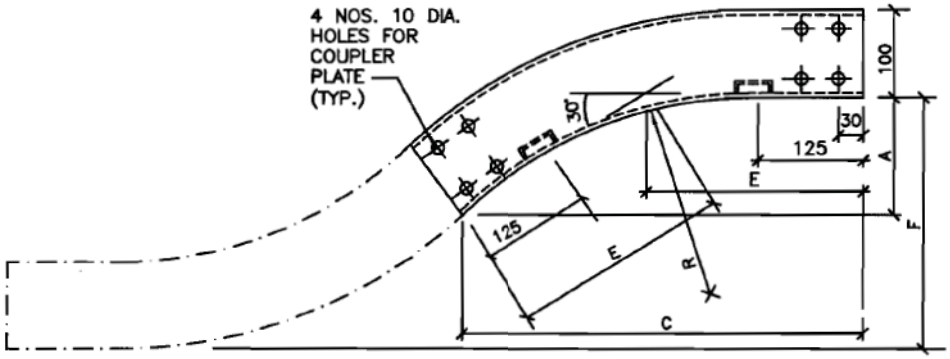
REV. 2 SHT. 07 OF 17



ELEVATION

30° VERTICAL ELBOW (INSIDE)

WIDTH(W)	RADIUS(R)	A	C	E	F
600 450 & 300	1050	205	760	410	410
	600	145	535	290	290
	450	125	460	250	250
	300	105	385	210	210



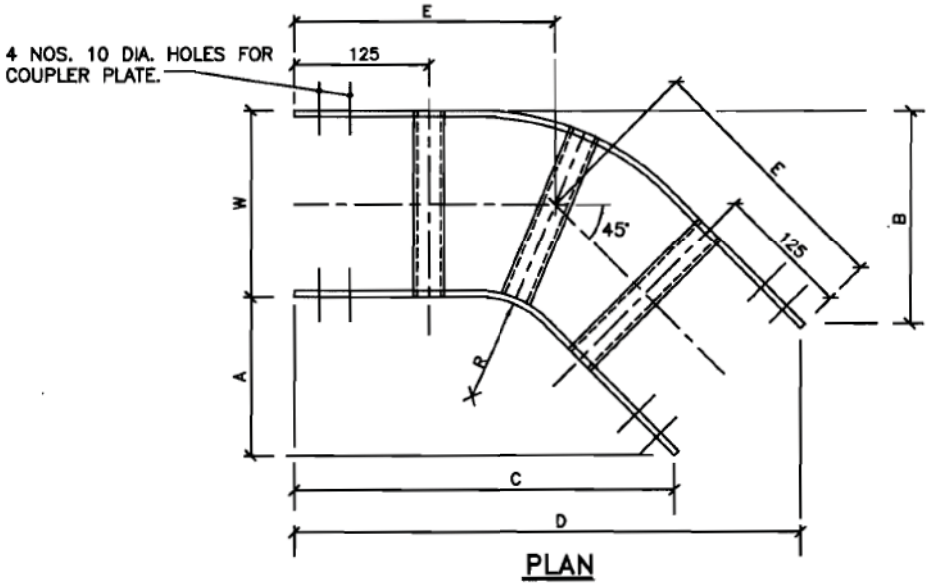
ELEVATION

30° VERTICAL ELBOW (OUTSIDE)

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
		REV. 2 SHT. 08 OF 17



PLAN

45° HORIZONTAL ELBOW

WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	395	570	955	1380	685
	600	265	440	640	1065	535
	450	220	395	530	955	470
	300	175	350	425	850	410
450	1050	395	530	955	1275	690
	600	265	395	640	955	500
	450	220	350	530	850	440
	300	175	310	425	745	390
300	1050	395	485	955	1165	655
	600	265	350	640	850	470
	450	220	310	530	745	410
	300	175	265	425	635	345

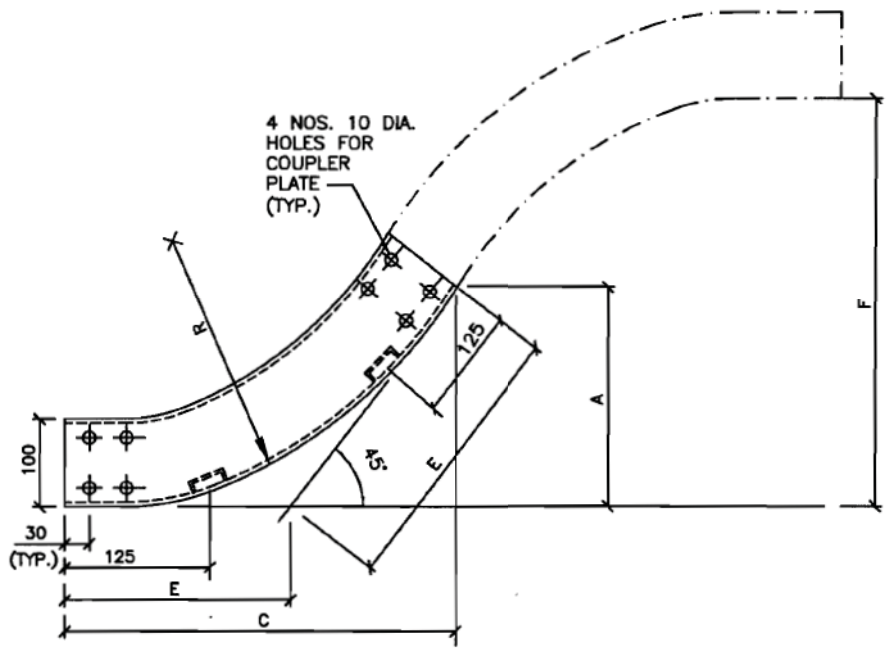
NOTE :-

1. ALL DIMENSIONS ARE IN MM.

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

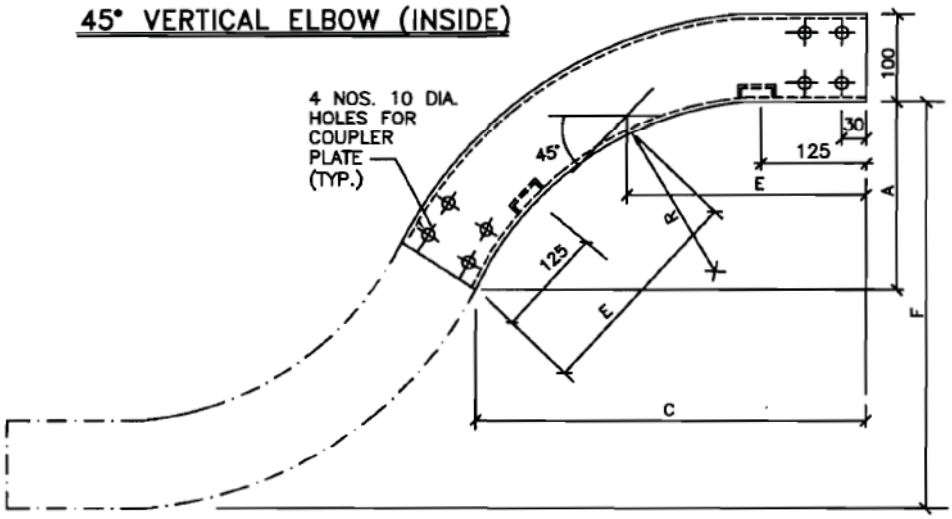
DWG. NO. PE-DG-417-507-E005

REV. 2 SHT. 09 OF 17



ELEVATION

45° VERTICAL ELBOW (INSIDE)



ELEVATION

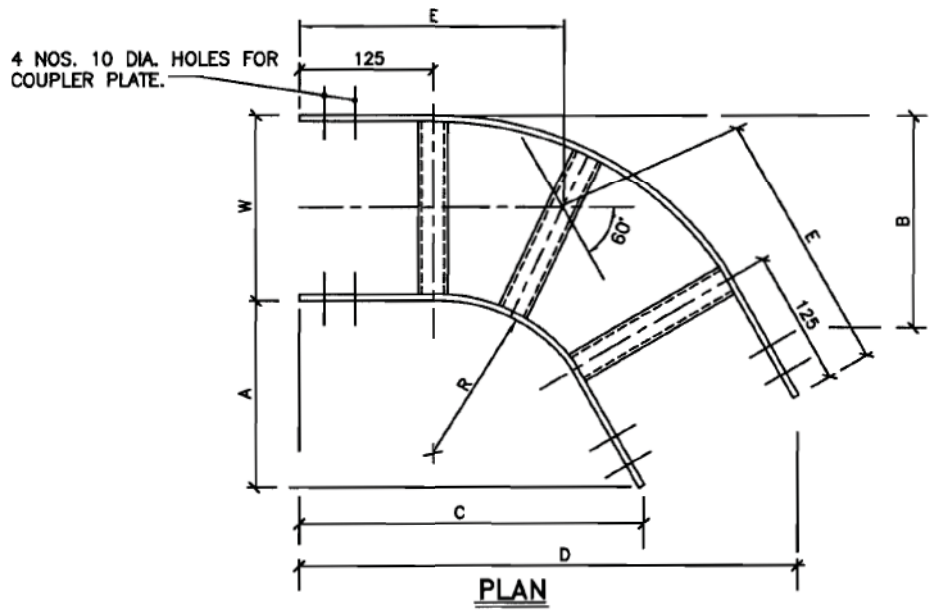
45° VERTICAL ELBOW (OUTSIDE)

WIDTH(W)	RADIUS(R)	A	C	E	F
600 450 & 300	1050	395	955	560	790
	600	265	640	375	530
	450	220	530	310	440
	300	175	425	250	350

NOTE :-

1. ALL DIMENSIONS ARE IN MM.

	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
		REV. 2 SHT. 10 OF 17



PLAN

60° HORIZONTAL ELBOW

WIDTH (W)	RADIUS (R)	A	B	C	D	E
600	1050	635	935	1095	1615	905
	600	410	710	705	1225	645
	450	335	635	575	1095	560
	300	250	550	450	965	470
450	1050	635	860	1095	1485	860
	600	410	635	705	1095	600
	450	335	550	575	965	515
	300	250	485	450	835	425
300	1050	635	785	1095	1355	815
	600	410	560	705	965	555
	450	335	485	575	835	470
	300	250	410	450	705	385

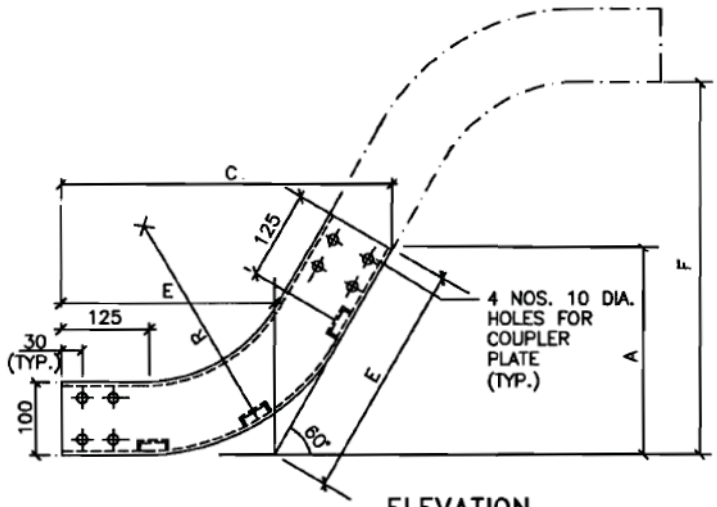
NOTE :-

1. ALL DIMENSIONS ARE IN MM.

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

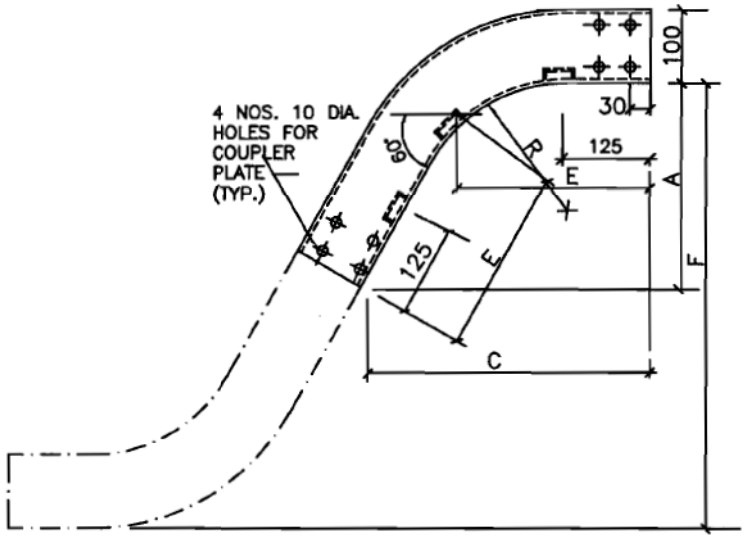
DWG. NO.
PE-DG-417-507-E005

REV. 2 | SHT. 11 OF 17



ELEVATION

60° VERTICAL ELBOW (INSIDE)



ELEVATION

60° VERTICAL ELBOW (OUTSIDE)

WIDTH(W)	RADIUS(R)	A	C	E	F
600 450 & 300	1050	635	1095	730	1270
	600	410	705	470	820
	450	335	575	385	670
	300	260	450	300	520

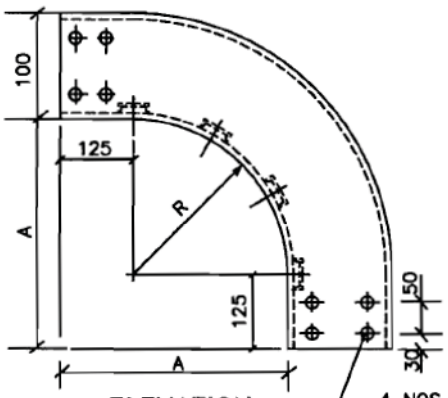
NOTE :-

1. ALL DIMENSIONS ARE IN MM.

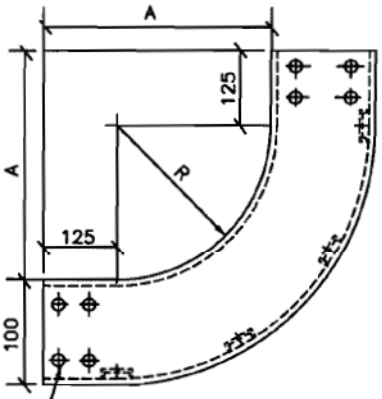
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

DWG. NO.
PE-DG-417-507-E005

REV. 2 | SHT. 12 OF 17



ELEVATION
90° VERTICAL ELBOW
(OUTSIDE)

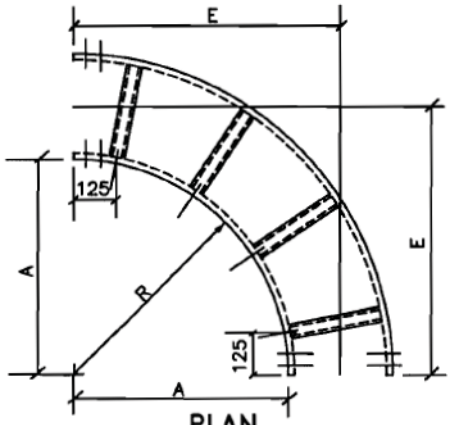


4 NOS. 10 DIA. HOLES FOR COUPLER PLATE

ELEVATION
90° VERTICAL ELBOW
(INSIDE)

VERTICAL ELBOW		
WIDTH (W)	RADIUS (R)	A
600 450 & 300	1050	1175
	600	725
	450	575
	300	425

HORIZONTAL ELBOW			
WIDTH (W)	RADIUS (R)	A	E
600	1050	1175	1475
	600	725	1025
	450	575	875
	300	425	725
450	1050	1175	1400
	600	725	950
	450	575	800
	300	425	650
300	1050	1175	1325
	600	725	875
	450	575	725
	300	425	575

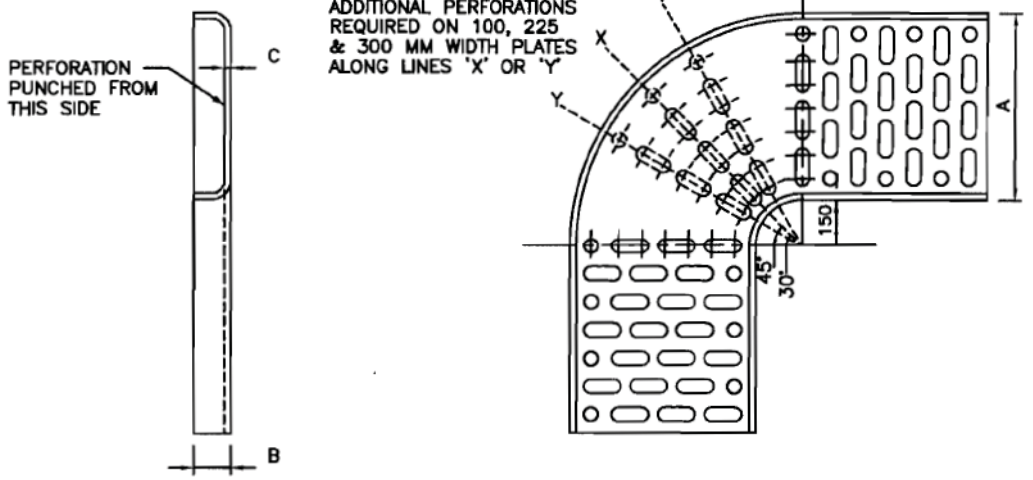


PLAN
90°HORIZONTAL ELBOW

NOTES :-

1. ALL DIMENSIONS ARE IN MM.
2. FOR MULTITIER CABLE TRAY, THE BENDING RADIUS AT THE BENDS SHALL BE SAME FOR ALL TRAYS AND THIS RADIUS SHALL BE AS PER THE RECOMMENDED BENDING RADIUS OF LARGEST CABLE IN THE ROUTE

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
	REV. 2 SHT. 13 OF 17

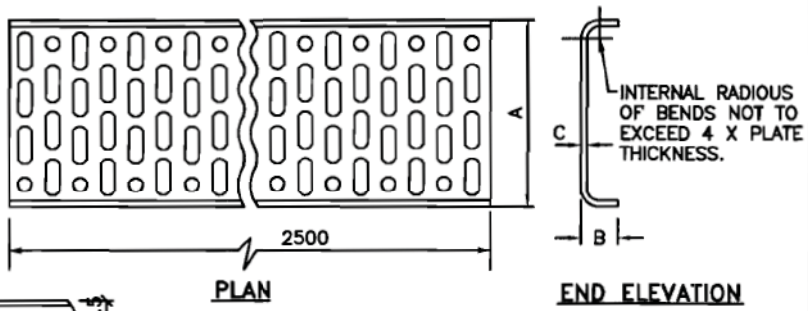


END ELEVATION

PLAN

DIMENSIONS IN MM	
WIDTH–A	DEPTH–B
100	50
150	
300	100
450	100
600	100

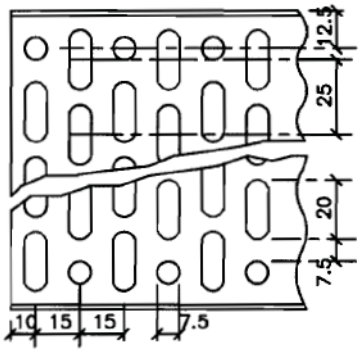
90° HORIZONTAL ELBOW



PLAN

END ELEVATION

STRAIGHT LENGTH



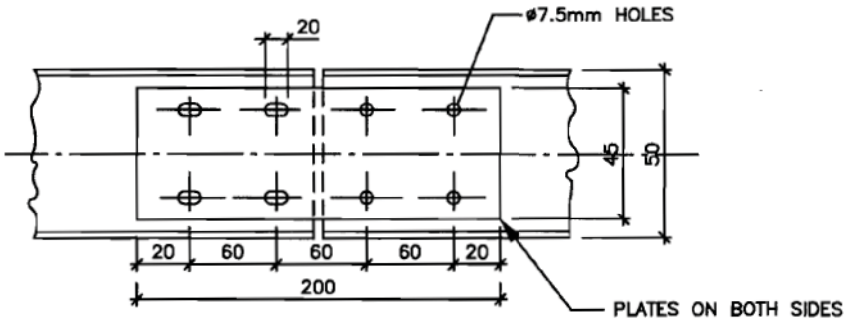
DETAILS OF PERFORATION

NOTES :

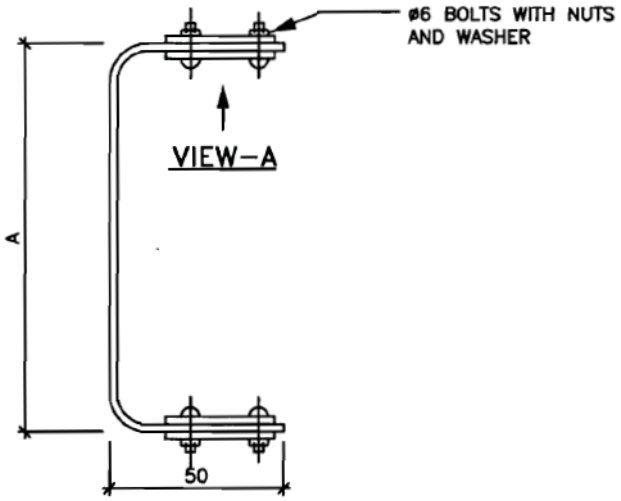
1. ALL CUTTING & FORMING OPERATIONS TO BE COMPLETED PRIOR TO GALVANIZING.
2. FINISHED TRAYS TO BE FREE FROM BURRS AND SHARP EDGES.
3. ALL DIMENSIONS ARE IN MM.

PERFORATED TYPE CABLE TRAY

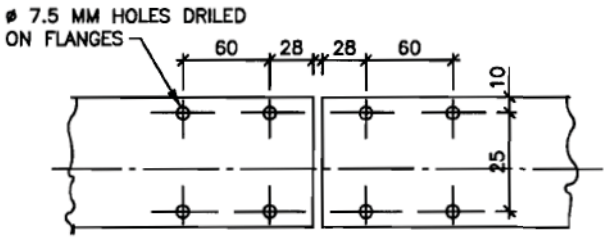
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417-507-E005
	REV. 2 SHT. 14 OF 17



VIEW–A



END ELEVATION



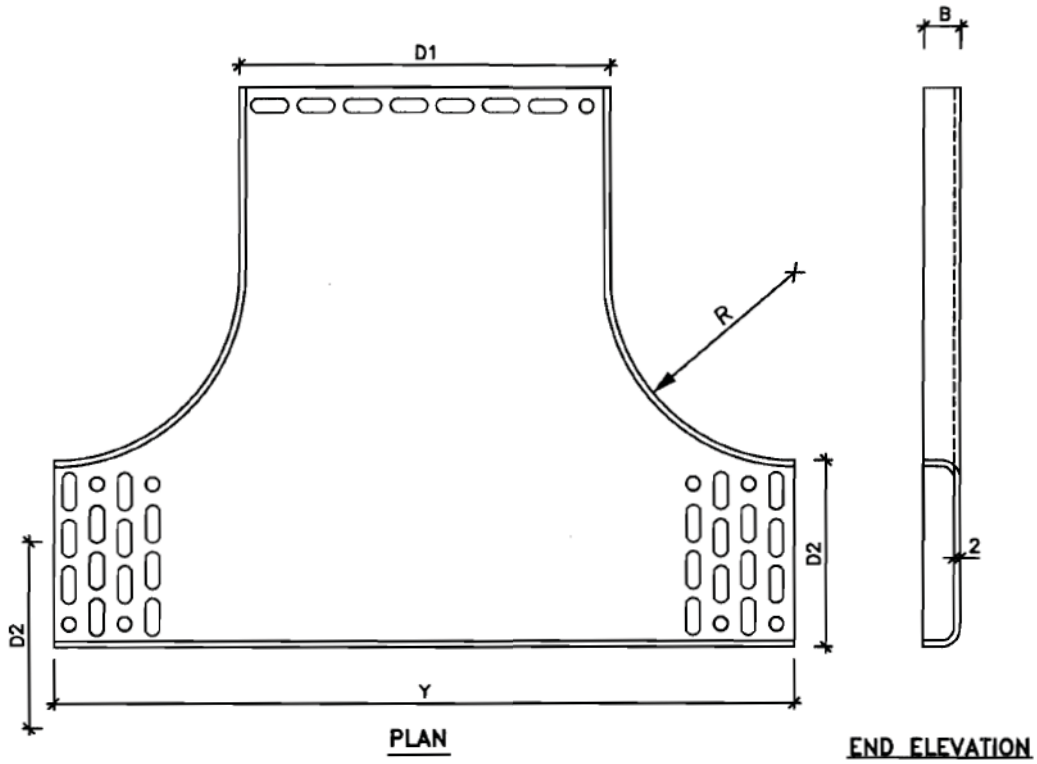
COUPLING PLATE

NOTES:–

1. COUPLING PLATES 2 MM THICK M.S.
2. ALL DIMENSIONS ARE IN MM.

PERFORATED TRAY JOINING BY COUPLING PLATES

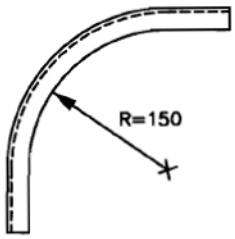
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE–DG–417–507–E005
	REV. 2 SHT. 15 OF 17



PLAN

END ELEVATION

HORIZONTAL TEE



VERTICAL ELBOW (90°)

TYPE	DIMENSIONS IN MM				
	D1	D2	B	R	Y
A	225	100	50	150	500
B	300	150	50	200	600

PERFORATED TRAY FITTINGS

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE-DG-417 -507-E005
	REV. 2 SHT. 16 OF 17

NOTES:–

1. THE LADDER AND PERFORATED TYPE CABLE TRAYS AND ACCESSORIES (INCLUDING SIDE RUNNERS OF LADDER TYPE CABLE TRAYS), SIDE COUPLER PLATE AND CABLE TRAY COVER SHALL BE MADE OF HOT DIP GALVANISED AS PER IS 1079.THICKNESS OF CABLE TRAYS &ACCESSORIES, SIDE COUPLER PLATE AND TRAY COVERS SHALL BE 2MM, 2MM AND 2.0 MM RESPECTIVELY. 1
2. THE CABLE TRAYS ACCESSORIES AND TRAY COVERS SHALL BE HOT DIP AS PER IS 2629.GALVANIZATION SHALL BE UNIFORM & THICKNESS OF GALVANIZATION SHALL NOT BE LESS THAN 610 GRAMS/ SQ.MTR. ALSO ZINC DEPOSIT THICKNESS AT ANY POINT SHALL NOT BE LESS THAN 75 MICRONS.
3. FOR LADDER TYPE CABLE TRAYS AND ACCESSORIES, ALL RUNGS SHALL BE SLOTTED.
4. PERFORATED TRAYS SHALL BE FABRICATED OUT OF A SINGLE M.S. SHEET.
5. STANDARD TRAY ACCESSORIES SHALL BE WITH THE RADIUS INDICATED IN THIS DRAWING.
6. THE DIMENSIONS OF ALL BENDS, TEES, CROSSES, ETC. FOR PERFORATED CABLE TRAYS SHALL BE THE SAME AS FOR LADDER TYPE TRAY FITTINGS.
7. SIDE CHANNELS OF PERFORATED TRAY ACCESSORIES SHALL BE WELDED WITH THE PERFORATED SHEET AT INTERVALS OF 100mm.
8. LENGTH OF WELDING SHALL NOT BE LESS THAN 25mm.
9. ALL TRAY CORNERS SHALL BE SMOOTH AND FREE OF SHARP EDGES.
10. THE DEPTH, WIDTH AND LENGTH OF TRAYS SHALL BE WITHIN A TOLERANCE OF (+/–) 2 mm. THE THICKNESS TOLERANCE IS OF (+/–) 0.2 mm. AS PER IS:1852
11. TO FACILITATE ASSEMBLY, ALL ACCESSORIES AT ENDS SHALL HAVE 100mm STRAIGHT PORTION.
12. ALL NUTS, BOLTS, WASHERS ETC., SHALL BE HOT DIP GALVANISED AS PER IS:1367 PART XIII FOR SIZES 12 MM & ABOVE AND ELECTROPLATED/ZINC PASSIVATED FOR SIZES BELOW 12 MM.
13. ALL CUTTING & FORMING OPERATIONS SHALL BE COMPLETED PRIOR TO GALVANIZING.
14. FINISHED TRAYS SHALL BE FREE FROM BURRS AND SHARP EDGES.
15. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
16. TOP MOST CABLE TRAY OF A HORIZONTAL RUN AND FRONT CABLE TRAY OF A VERTICAL RUN IN ALL OUTDOOR AREAS SHALL BE PROVIDED WITH REMOVABLE TRAY COVER.
17. THE PORTION OF GALVANIZED STEEL, WHICH, IF REQUIRED, UNDERGOES ANY WELDING AT SITE, SHALL BE COATED WITH TWO COATS OF COLD GALVANIZING ANTI–CORROSIVE PAINT AFTER WELDING. EPOXY PAINT SHALL BE APPLIED IN CABLE TRAY COVERS IN CHEMICAL CORROSIVE AREA. 2
18. WIDTH OF CABLE TRAYS PROPOSED TO BE USED FOR THE PROJECT ARE AS UNDER:

    A)LADDER TYPE: 600W, 450W, 300W, 150W.

    B)PERFORATED TYPE: 600W, 450W, 300W, 150W, 100W

    c) CABLE TROUGH 50W (FOR DETAIL REFER SHEET 3)
19. THE DEPTH OF 600W, 450W & 300W TRAYS & ACCESSORIES SHALL BE 100MM AND DEPTH OF 150W,100W TRAY SHALL BE 50MM.
20. A 2.5 METER STRAIGHT SECTION OF EACH TYPE OF CABLE TRAY OF WIDTH 600mm, 450mm ,300mm & 150 mm SHALL BE SIMPLY SUPPORTED AT TWO ENDS. A UNIFORMLY DISTRIBUTED LOAD OF 100 kg PER METER SHALL BE APPLIED ALONG THE LENGTH OF TRAY. THE MAXIMUM DEFLECTION AT MID SPAN SHALL NOT EXCEED 7 mm. 1

	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE–DG–417 –507–E005
		REV. 2 SHT. 17 OF 17

INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM

REV.	DATE	ALTD	CHD	APPD
04	30.04.2020	AVi	NNJ	PD

Document revised in line with customer comments dated 23.04.2020

REV.	DATE	ALTD	CHD	APPD
05	24.07.2020	AVi	NNJ	PD

Document revised in line with customer comments dated 16.06.2020

REV.	DATE	ALTD	CHD	APPD
03	14.02.2020	AVi	NNJ	PD

Document revised in line with customer comments dated 31.01.2020

JOB NO. 417

STATUS CONTRACT

DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD
02	02.01.20	AVi	NNJ	PD

Document revised in line with customer comments dated 22.10.19

REV.	DATE	ALTD	CHD	APPD
01	18.07.19	AVi	NNJ	PD

Document revised in line with customer comments dated 19.03.19

CUSTOMER:

TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS

TATA CONSULTING ENGINEERS LIMITED
BANGALORE INDIA

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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DEPT CODE		NAME	SIGN	DATE
E	DRN	AV	--SD--	08.12.17
	DESN	AV	--SD--	08.12.17
	CHD	NNJ	--SD--	08.12.17
	APPD	PD	--SD--	08.12.17

TITLE
INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM

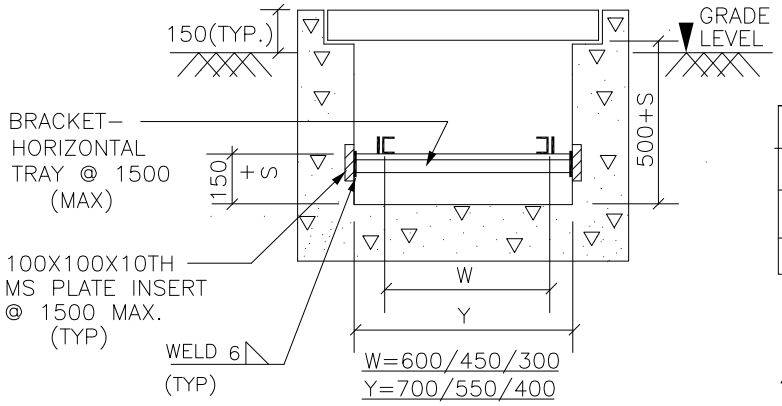
DEPT.	SCALE	DRAWING NO.
SIGN		PE-DG-417-507-E006
		SHEET 1 OF 15 REV. 05

NOTES :- 1

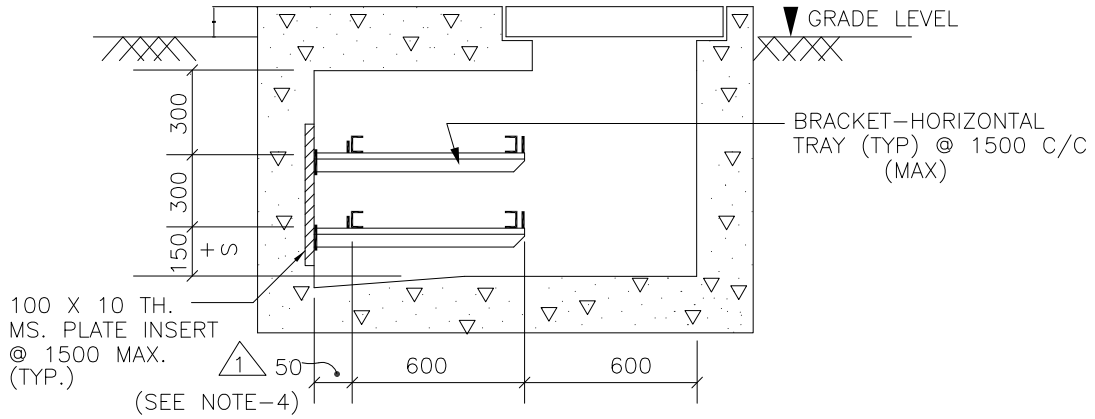
1. ALL DIMENSIONS ARE IN MM.
2. +S INDICATES DISTANCE TO MAINTAIN THE 'SLOPE' OF THE TRENCH.
3. MOUNTING ARRANGEMENT IN CABLE TRENCH TYPE–C,CC,DD ETC. SHALL BE SIMILAR. 1

TYPE	NO. OF TRAYS	BOTH SIDES
TYPE–C	3	NO
TYPE–CC	3	YES
TYPE–DD	4	YES

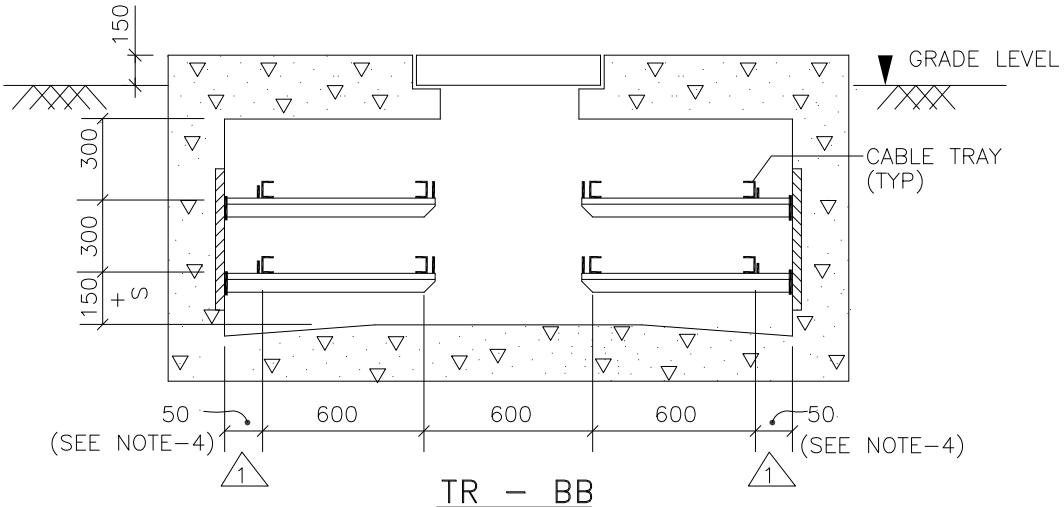
4. 1 FOR LONG TRENCH WITHOUT ANY INTERMEDIATE CABLE EXIT, IN STRAIGHT LENGTHS IT SHALL BE ATLEAST 50MM. HOWEVER, THE SAME SHALL BE PROVIDED FOR AT LEAST 1500mm ON EITHER SIDE OF THE EXIT.



TR – A



TR – B



TR – BB

MOUNTING ARRANGEMENT
(IN CABLE TRENCH)

	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE–DG–410–507–E006
		REV.05 SHT. 02 OF 15

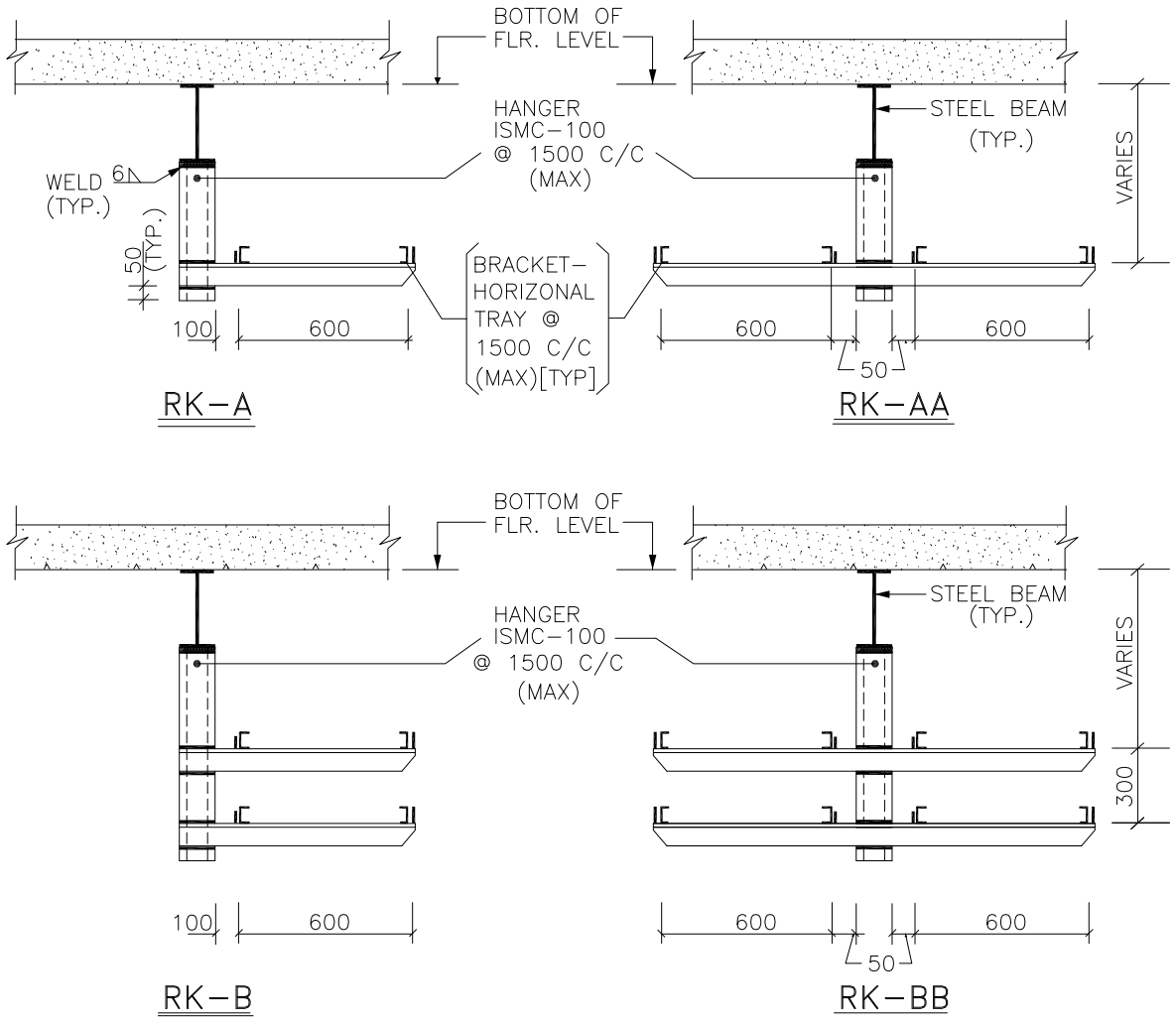


TABLE-1

RACK		NO. OF
TYPE	WIDTH	TIER
A1	450	1
B1	450	2
A2	300	1
B2	300	2

NOTES :-

1. ALL DIMENSIONS ARE IN MM.
2. FOR RACK TYPE RK-C, RK-CC, RK-D, RK-DD ETC. THE ARRANGEMENT SHALL BE SIMILAR. 1

TYPE	NO. OF TRAYS	BOTH SIDES
TYPE-C	3	NO
TYPE-CC	3	YES
TYPE-DD	4	YES

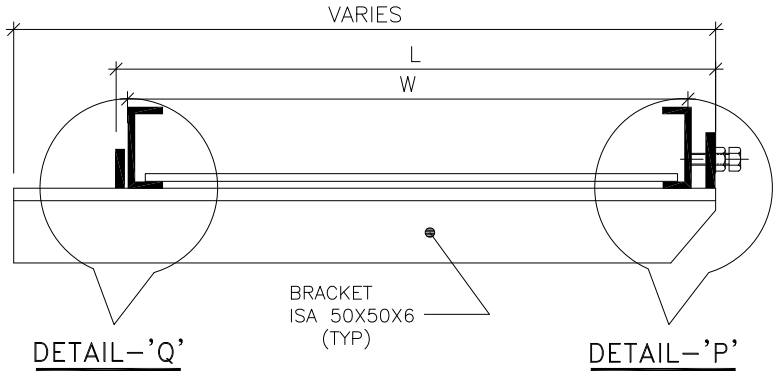
MOUNTING ARRANGEMENT

(FROM BEAM)

TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM

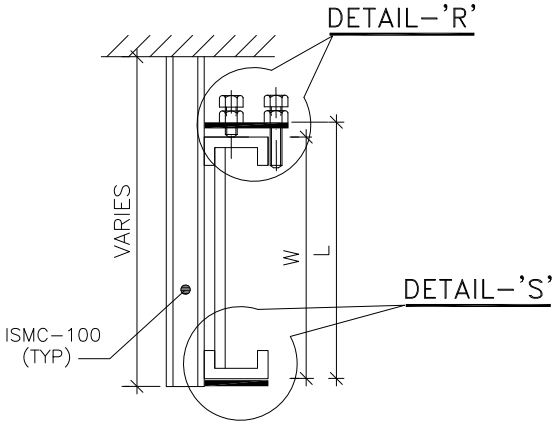
DWG. NO.
PE-DG-417-507-E006

REV. 05 SHT. 03 OF 15



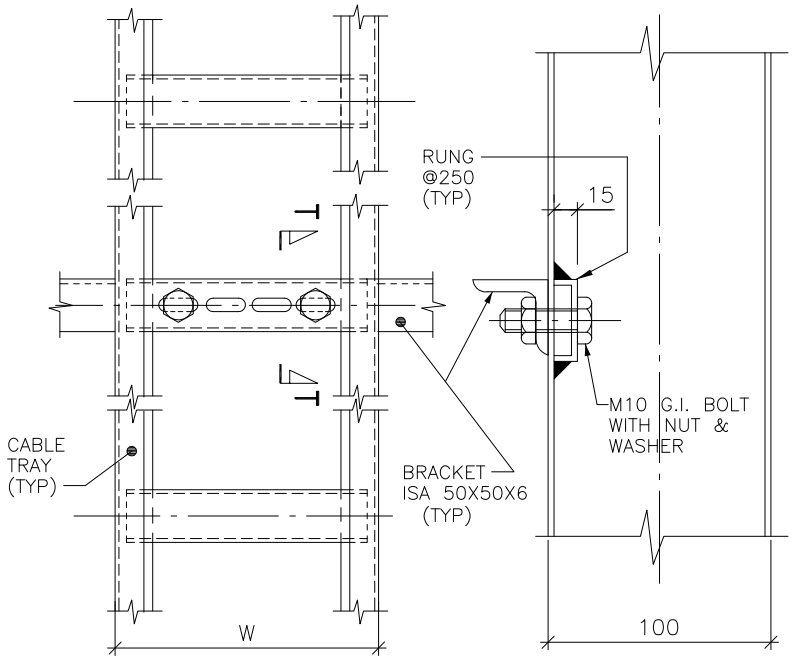
BRACKET

(HORIZONTAL CABLE TRAY)



BRACKET

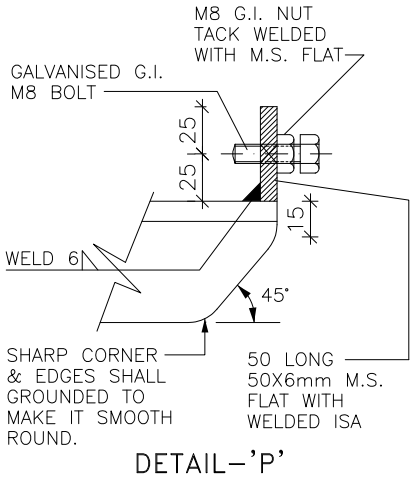
(VERTICAL CABLE TRAY)



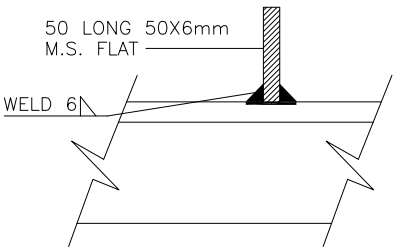
BRACKET

(VERTICAL CABLE SHAFT)

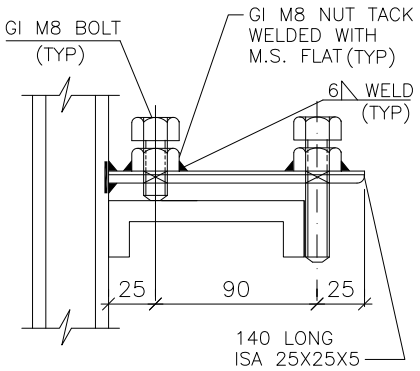
W	600	450	300
L	625	475	325



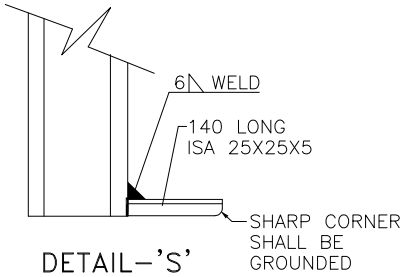
DETAIL–'P'



DETAIL–'Q'



DETAIL–'R'

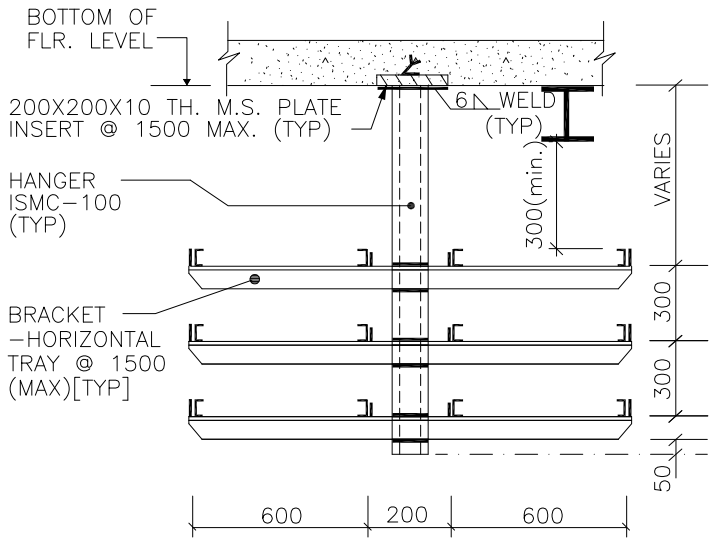


DETAIL–'S'

TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM

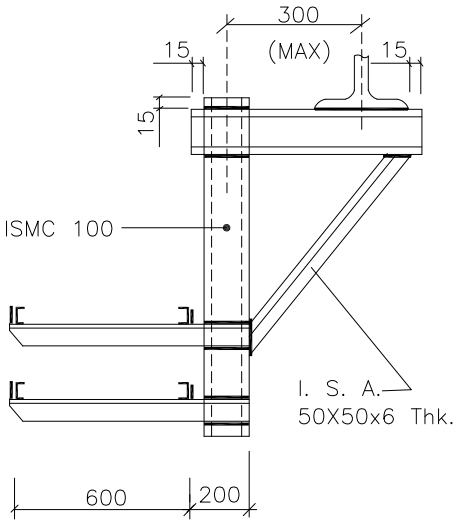
DWG. NO.
PE–DG–417–507–E006

REV. 05 SHT. 04 OF 15



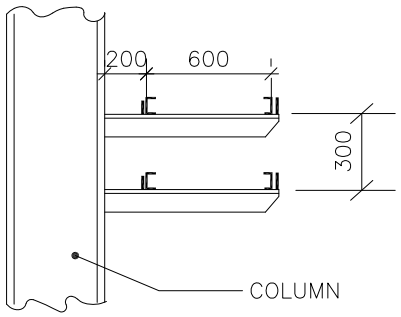
MOUNTING ARRANGEMENT

(FROM CEILING)



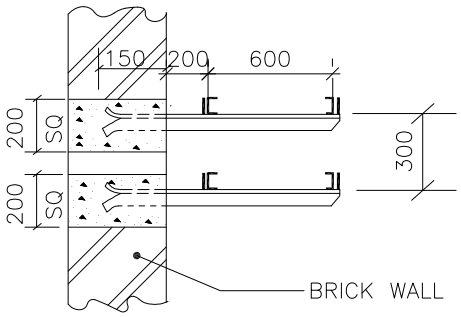
MOUNTING ARRANGEMENT

(FROM FLOOR BEAM)



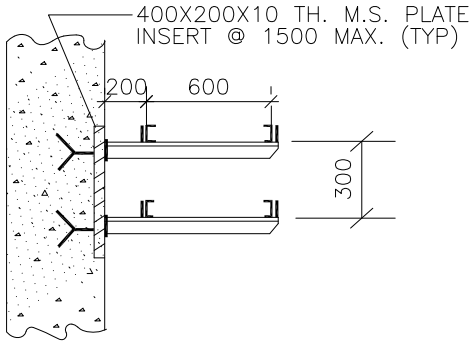
MOUNTING ARRANGEMENT

(FROM STEEL COLUMN)



MOUNTING ARRANGEMENT

(FROM BRICK WALL)



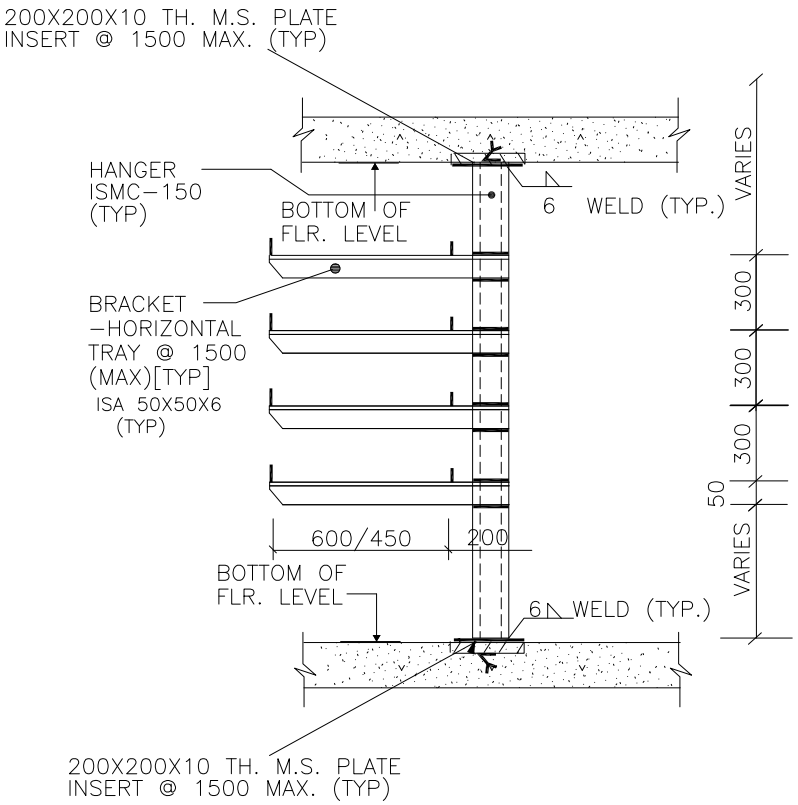
MOUNTING ARRANGEMENT

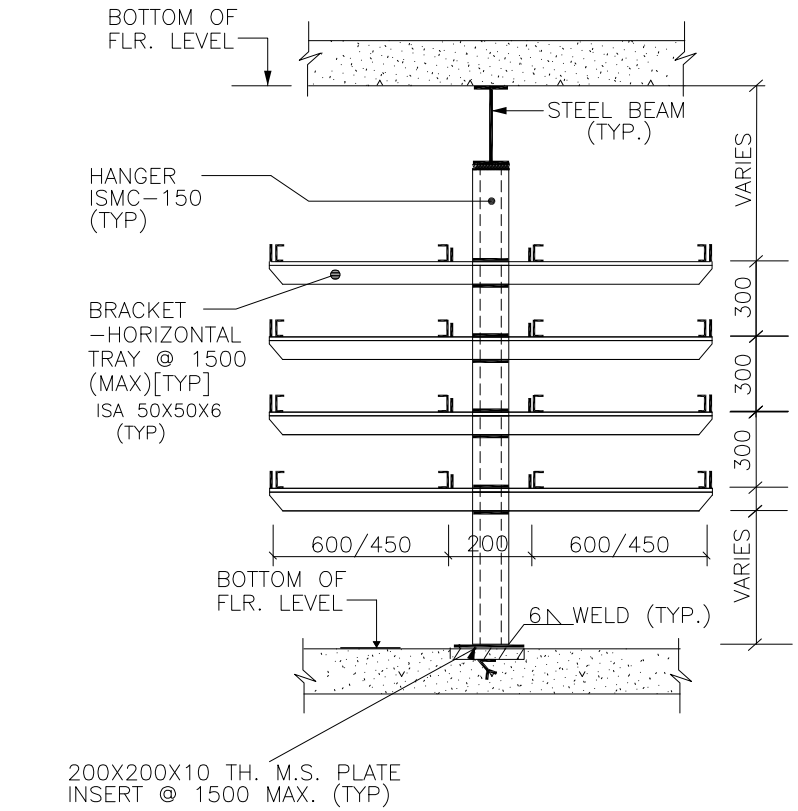
(FROM CONCRETE COLUMN)

NOTES :-

1. ALL DIMENSIONS ARE IN MM.
2. THE NOS. OF TIER AND WIDTH OF EACH TRAY SHALL BE AS PER RACK TYPE NOS.

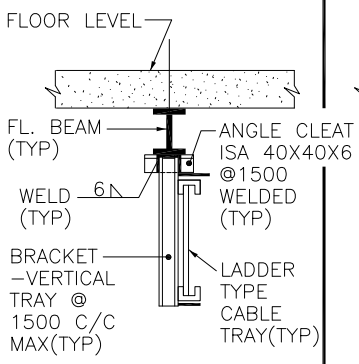
	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE-DG-417-507-E006
		REV. 05 SHT. 05 OF 15



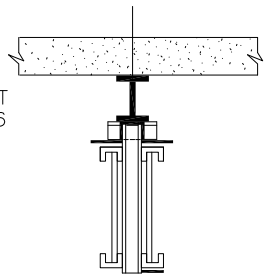


MOUNTING ARRANGEMENT (FOR MORE THAN THREE TRAYS)

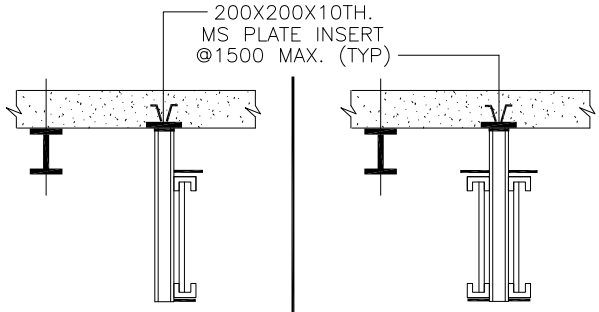
	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE–DG–417–507–E006
		REV. 05 SHT. 5A OF 15



STYLE–1

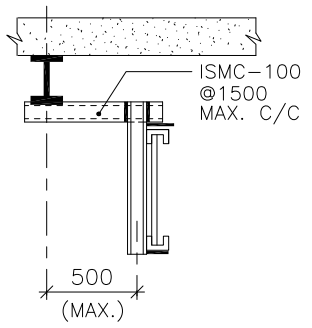


STYLE–2

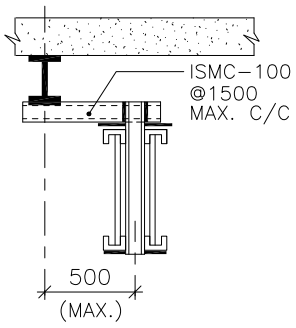


STYLE–3

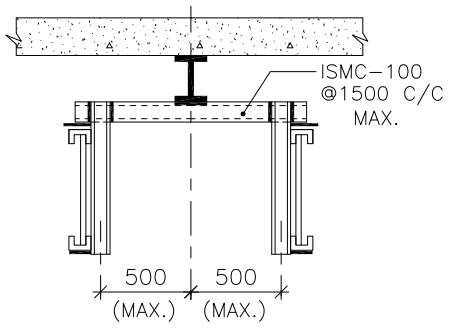
STYLE–4



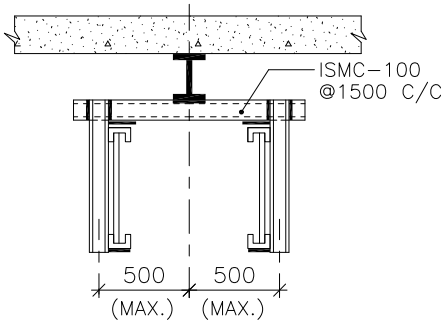
STYLE–5



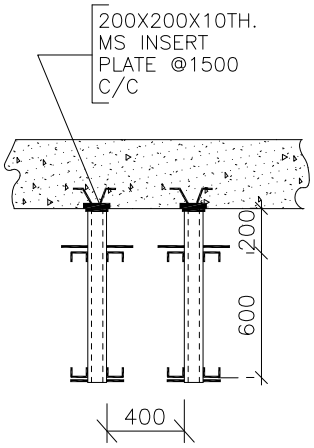
STYLE–6



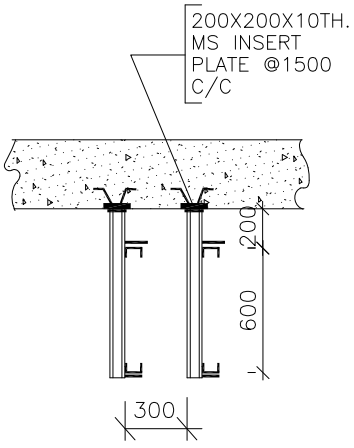
STYLE–7



STYLE–8



STYLE–9



STYLE–10

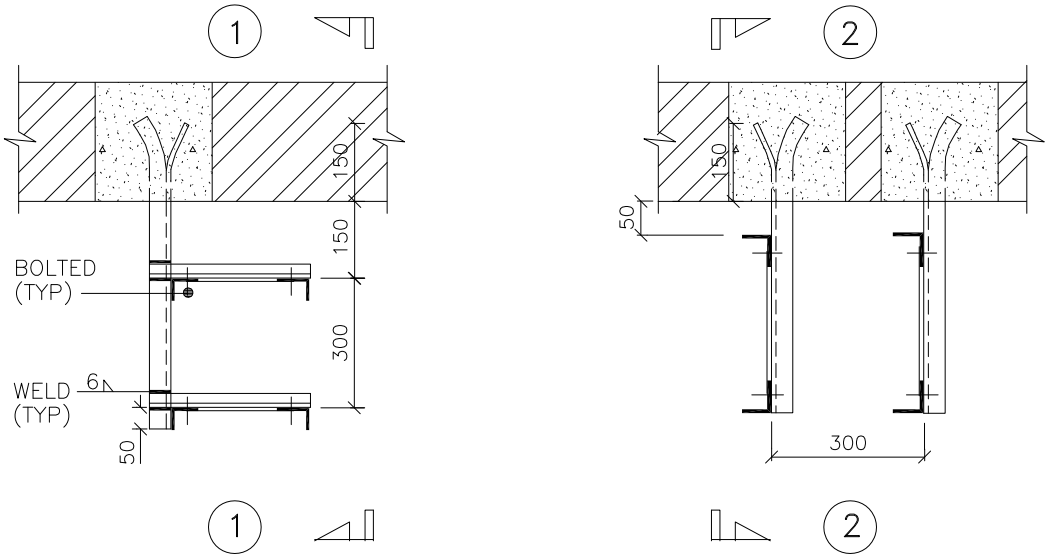
MOUNTING ARRANGEMENT

(VERTICAL CABLE TRAY)

TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM

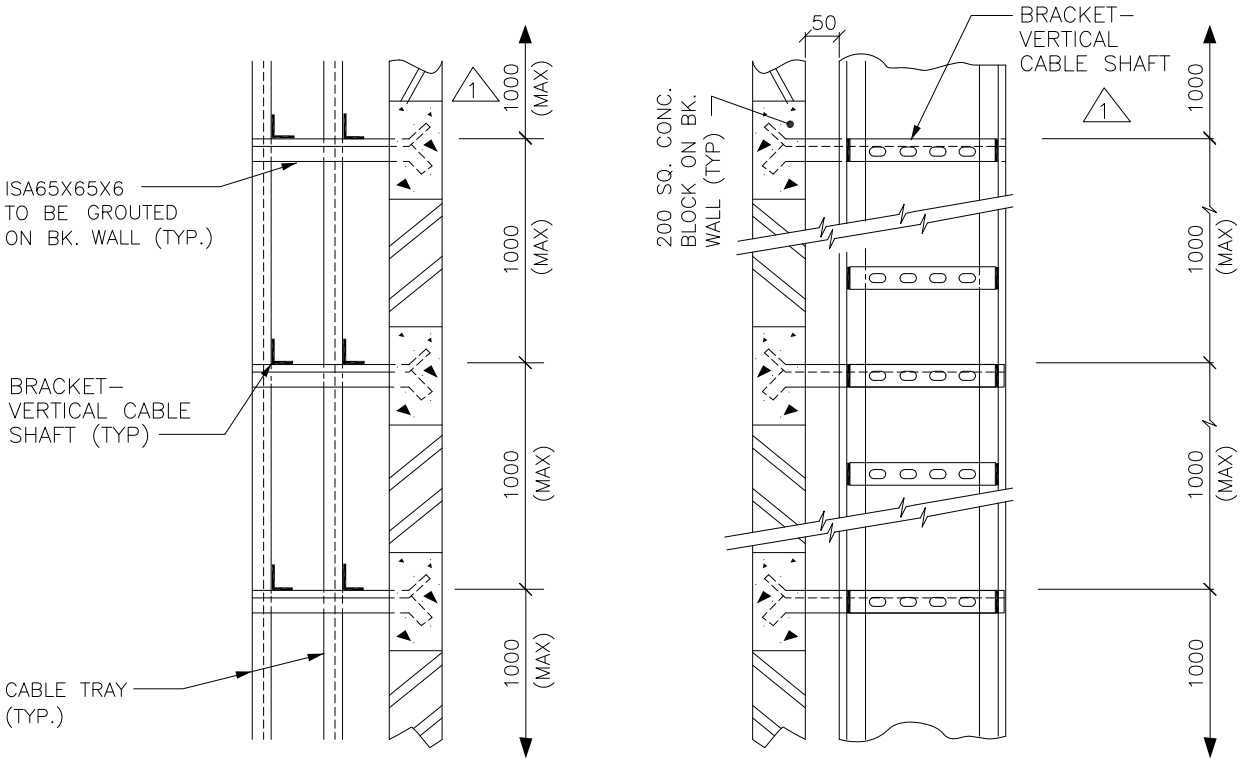
DWG. NO.
PE–DG–417–507–E006

REV. 05 SHT. 06 OF 15



PLAN
ALT.1

PLAN
ALT.2



SEC:1–1

SEC:2–2

SH–B

MOUNTING ARRANGEMENT

(CABLE SHAFT ON BRICKWALL)

NOTE

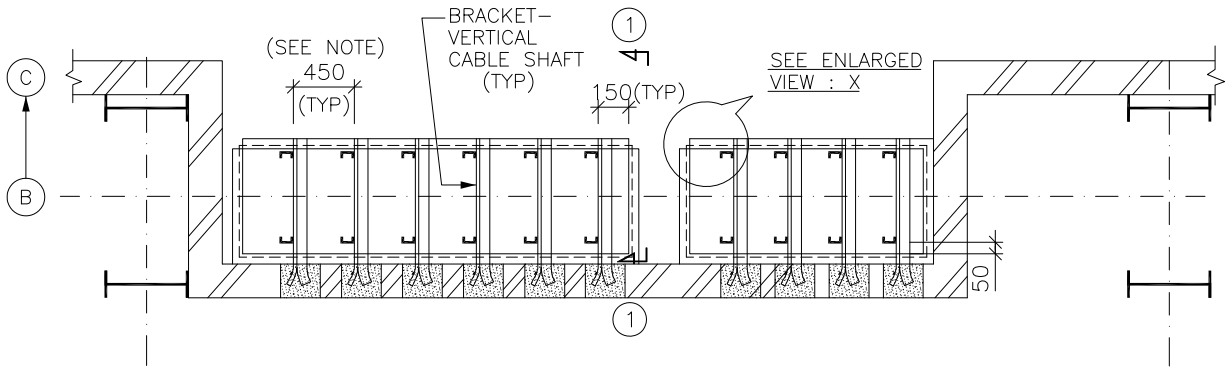
FOR CABLE SHAFT OF TYPE SH.–A, SH–C, THE ARRANGEMENT SHALL BE SIMILAR TO SH–B SHOWN HERE IN.

TYPE	NO. OF TRAYS
SH–A	1
SH–C	3

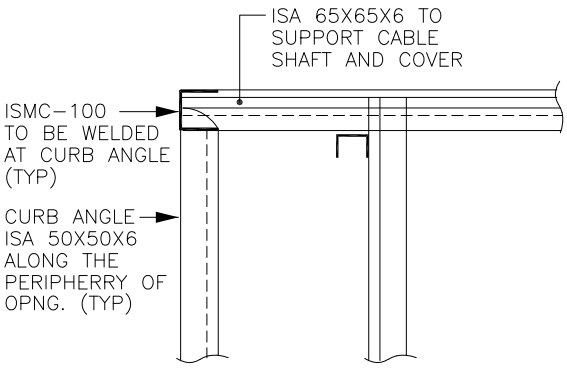
TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM

DWG. NO.
PE–DG–417–507–E006

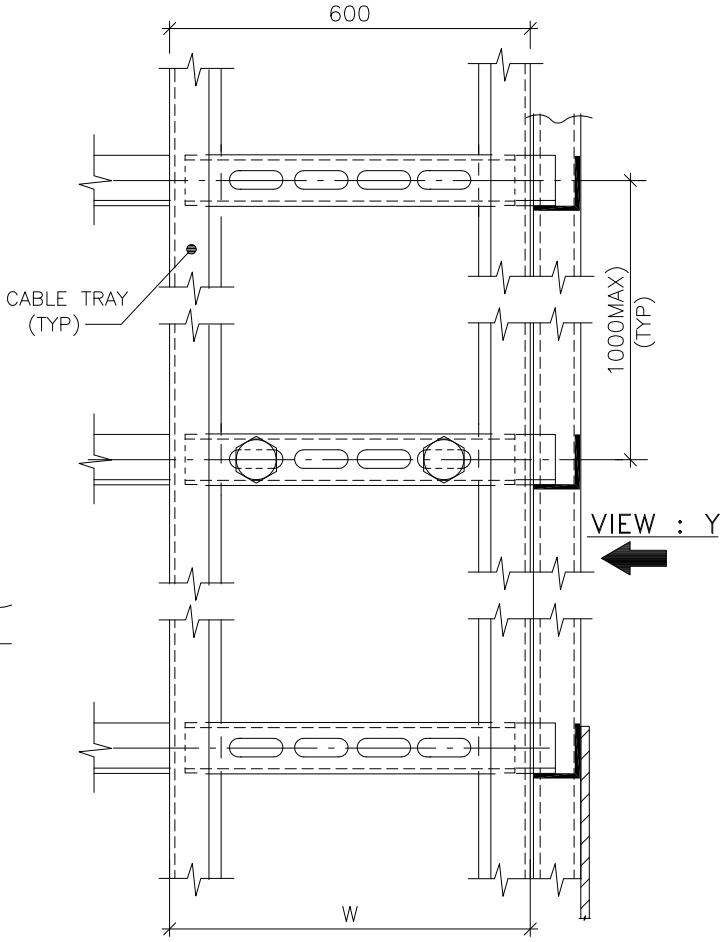
REV. 05 SHT. 07 OF 15

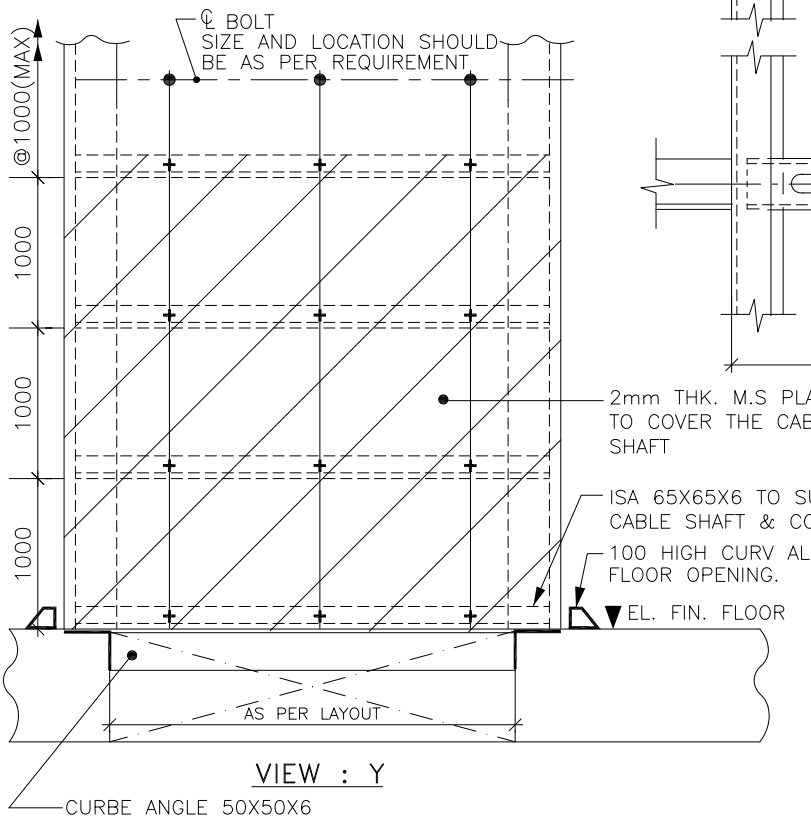


PLAN AT EL.3.5M



ENLARGED VIEW : X
TYPICAL DETAILS OF CABLE SHAFT





VIEW : Y

NOTE:–

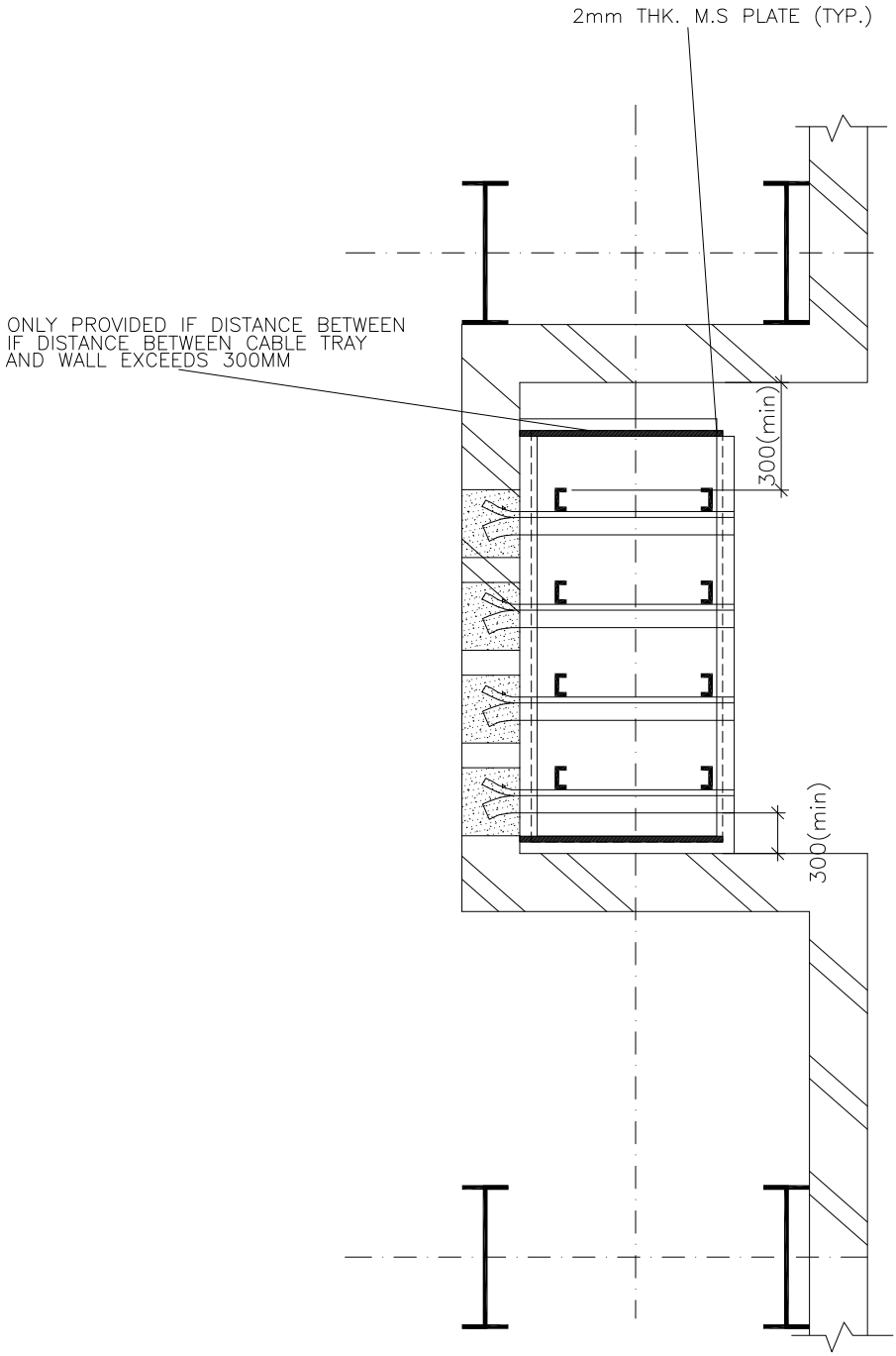
1 THE SPACING MAY BE REDUCED TO 300, IF CABLE TRAY IS APPROCHABLE FROM BOTH SIDE.

MOUNTING ARRANGEMENT
(CABLE SHAFT MAIN PLANT)

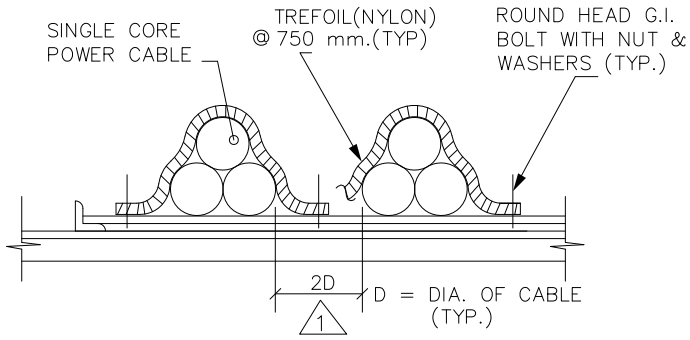
TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM

DWG. NO.
PE–DG–417–507–E006

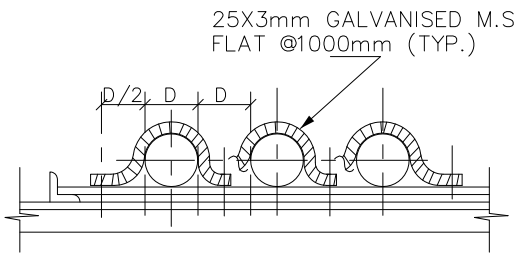
REV. 05 SHT. 08 OF 15



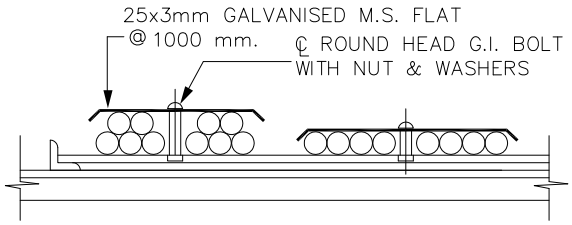
	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE-DG-417-507-E006
		REV. 05 SHT. 08A OF 15



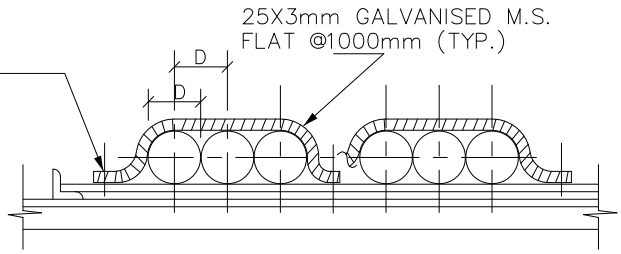
CABLE CLAMPS IN TREFOIL FORMATION FOR SINGLE CORE POWER CABLES



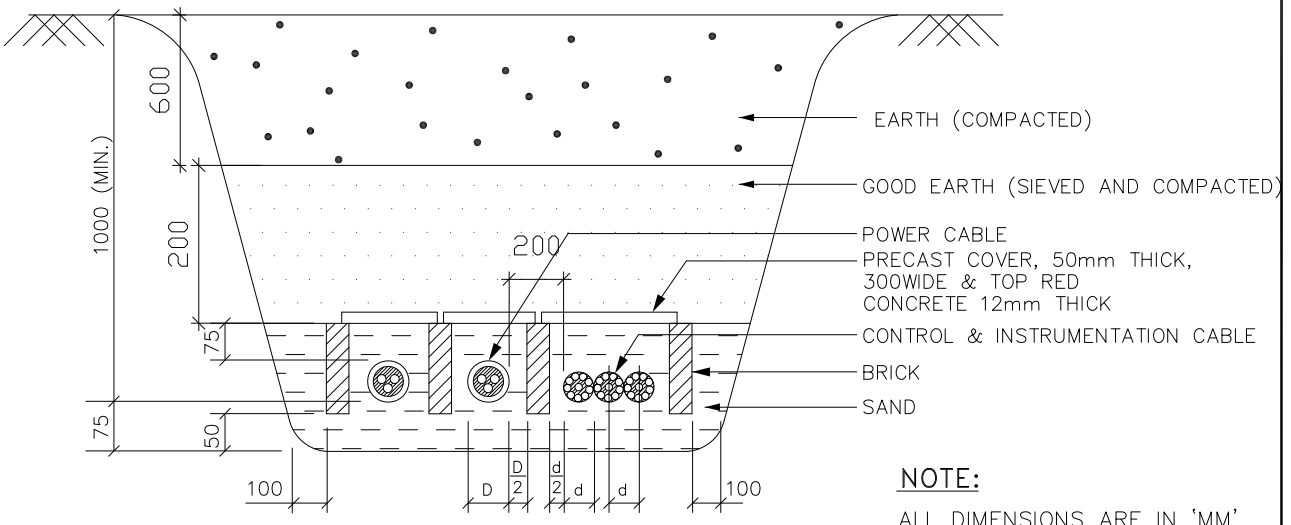
CABLE CLAMPS FOR MULTICORE POWER CABLES (NOT TOUCHING EACHOTHER)



CLAMPING ARRANGEMENT OF CONTROL CABLES



CABLE CLAMPS FOR MULTICORE POWER CABLES (TOUCHING EACHOTHER)



NOTE:

ALL DIMENSIONS ARE IN 'MM'.

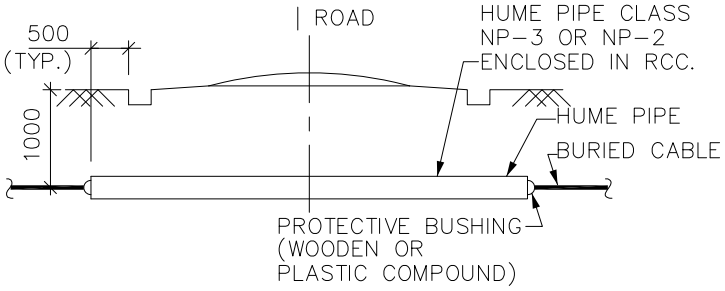
BURIED CABLE LAYING DETAILS

2

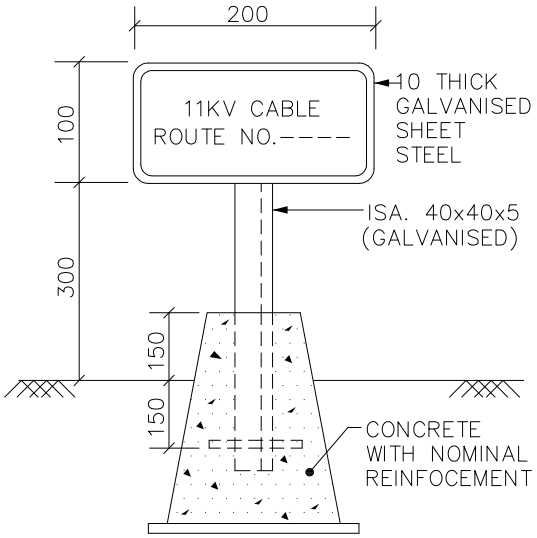
TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM

DWG. NO.
PE-DG-417-507-E006

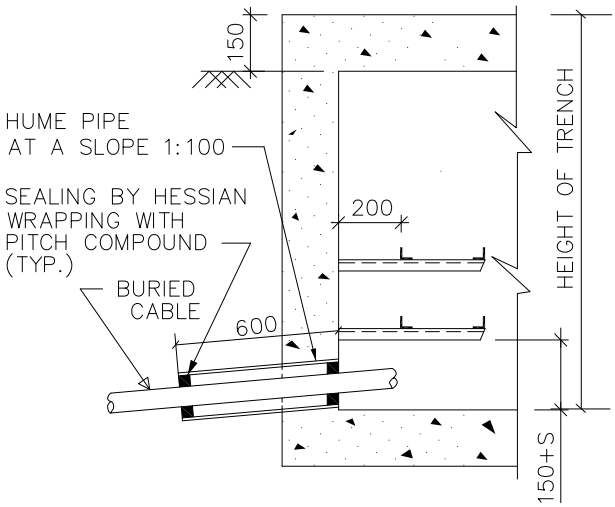
REV. 05 SHT. 09 OF 15



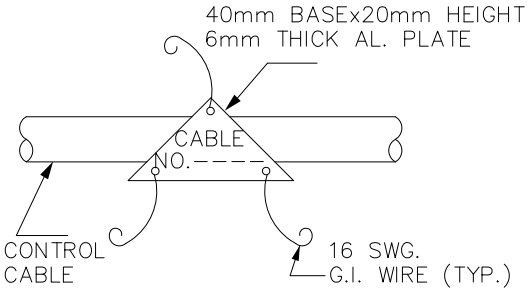
ROAD CROSSING
OF BURIED CABLE



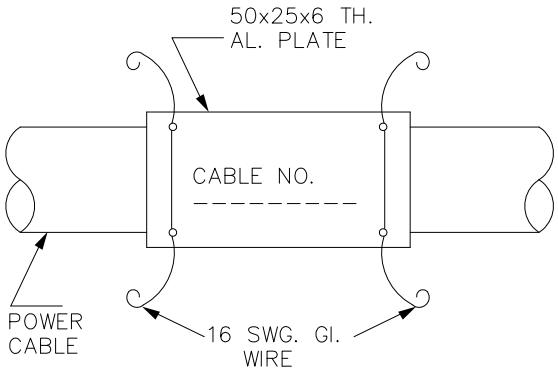
CABLE ROUTE MAKER
(VOLTAGE TO BE MARKED)



TYP. DETAILS OF BURIED CABLE
ENTRY TO BLDG. OR CABLE TRENCH



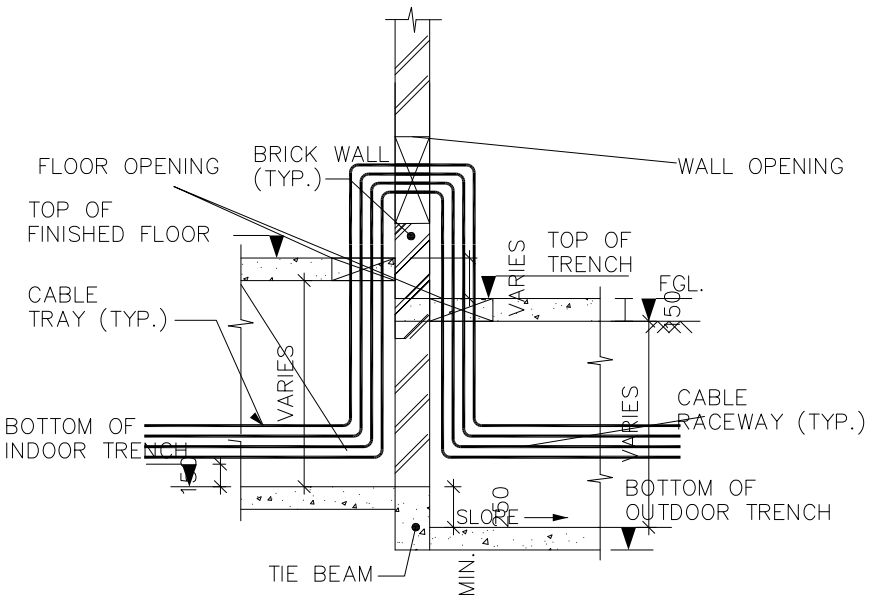
CABLE TAG
CONTROL CABLE



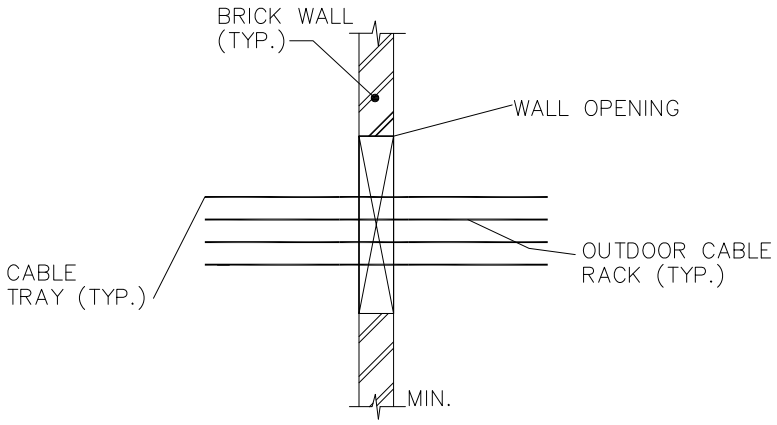
CABLE TAG
POWER CABLE

NOTE:
ALL DIMENSIONS ARE IN 'MM'.

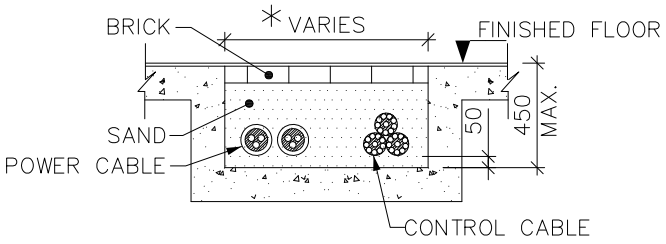
BHEL	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE-DG-417-507-E006 REV. 05 SHT. 10 OF 15



TYPICAL DETAILS OF CABLE TRENCH ENTRY TO BUILDING



TYPICAL DETAILS OF CABLE RACK ENTRY TO BUILDINGS

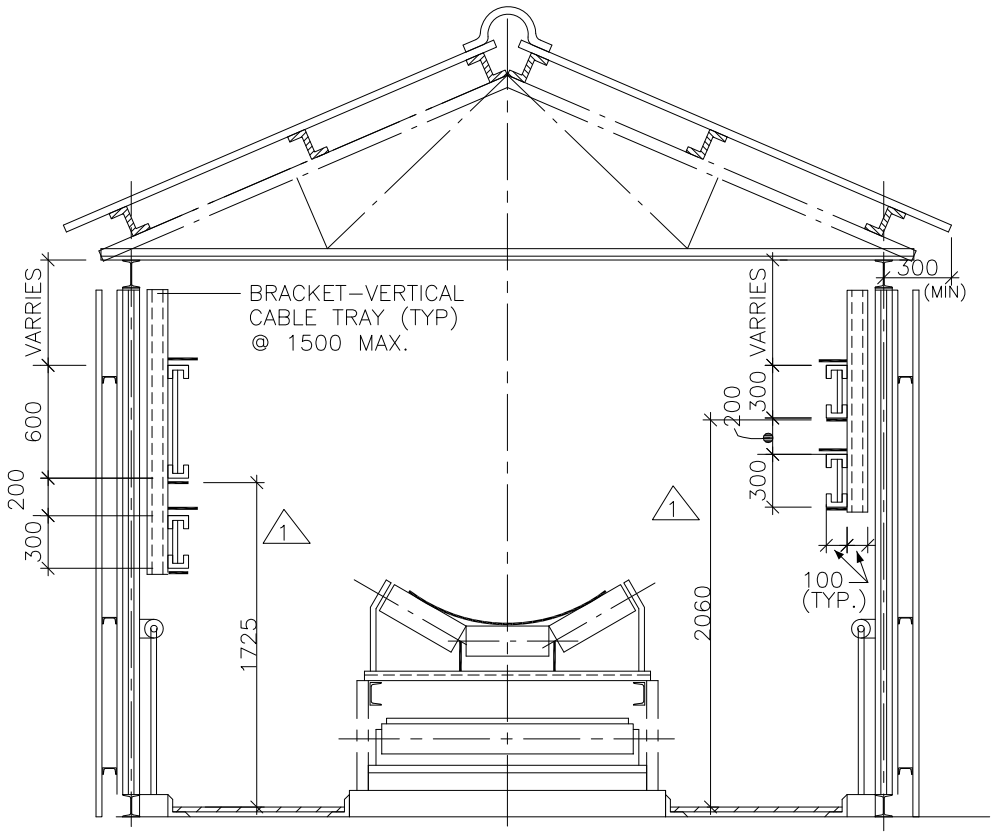


CABLE LAYING IN SHALLOW TRENCH (INDOOR)

NOTE:

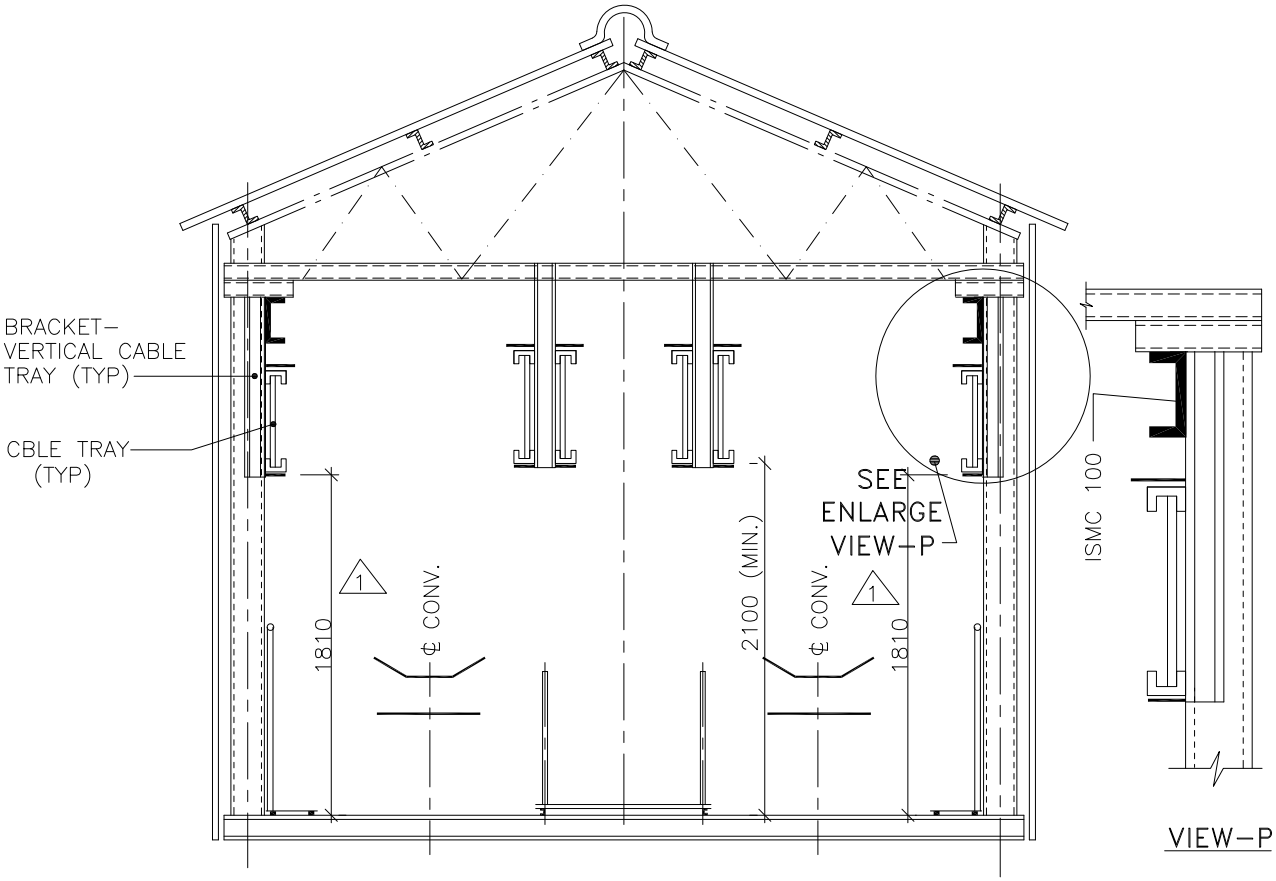
1. ALL DIMENSIONS ARE IN 'MM'.
2. THE PORTION OF FLOOR ABOVE THE TRENCH MARKED '*' SHALL BE FINISHED WITH WEAK MORTER.

BHEL	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE-DG-417-507-E006 REV. 05 SHT. 11 OF 15



MOUNTING ARRANGEMENT

(INSIDE CONV. GALLERY–ALT–I)

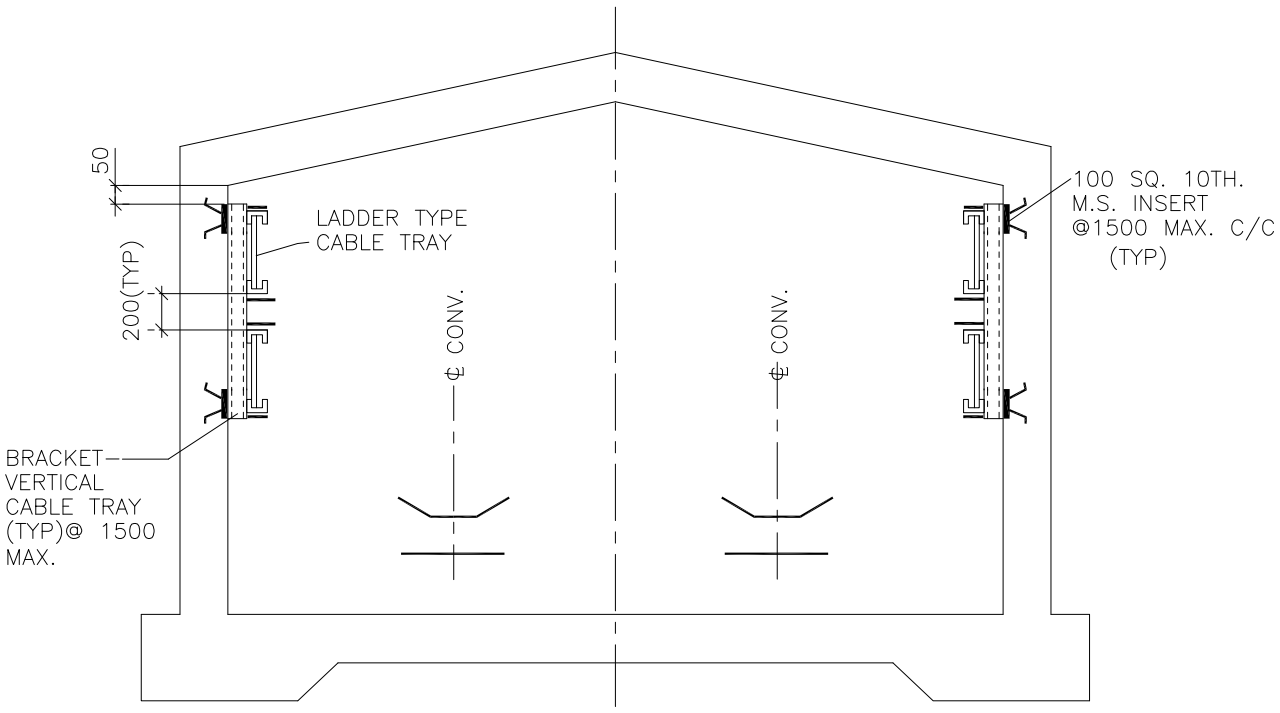


VIEW–P

MOUNTING ARRANGEMENT

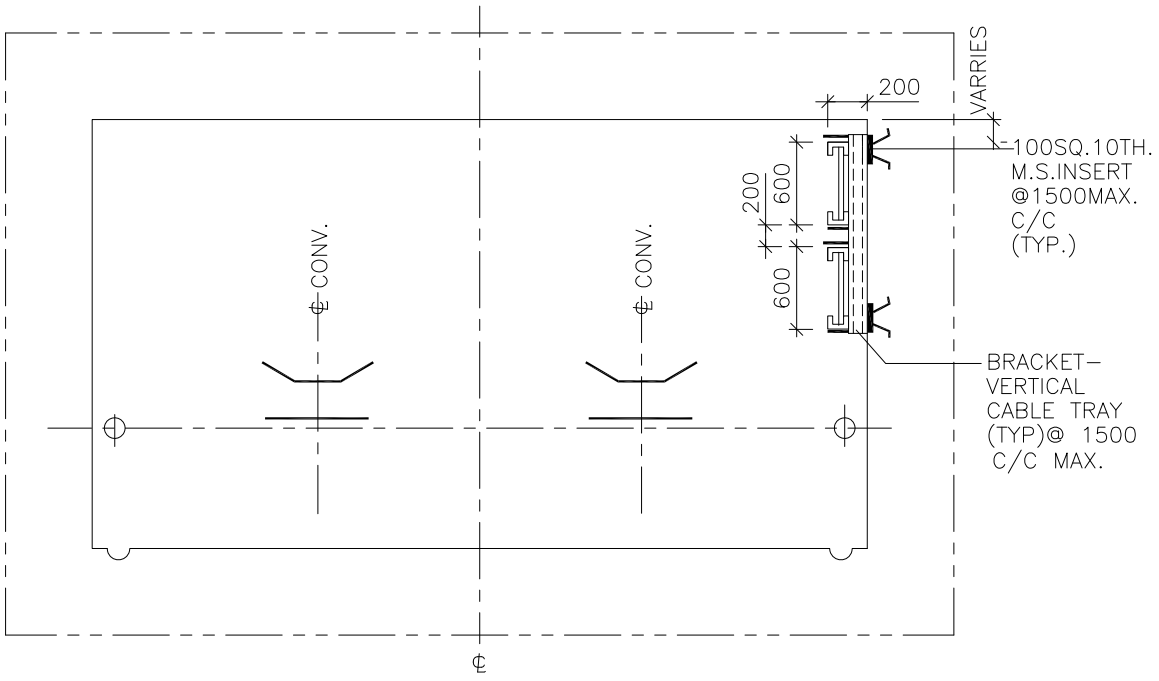
(INSIDE CONV. GALLERY–ALT–II)

	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE–DG–417–507–E006
		REV. 05 SHT. 12 OF 15



MOUNTING ARRANGEMENT

(IN CONVEYOR TUNNEL–ALT–I)



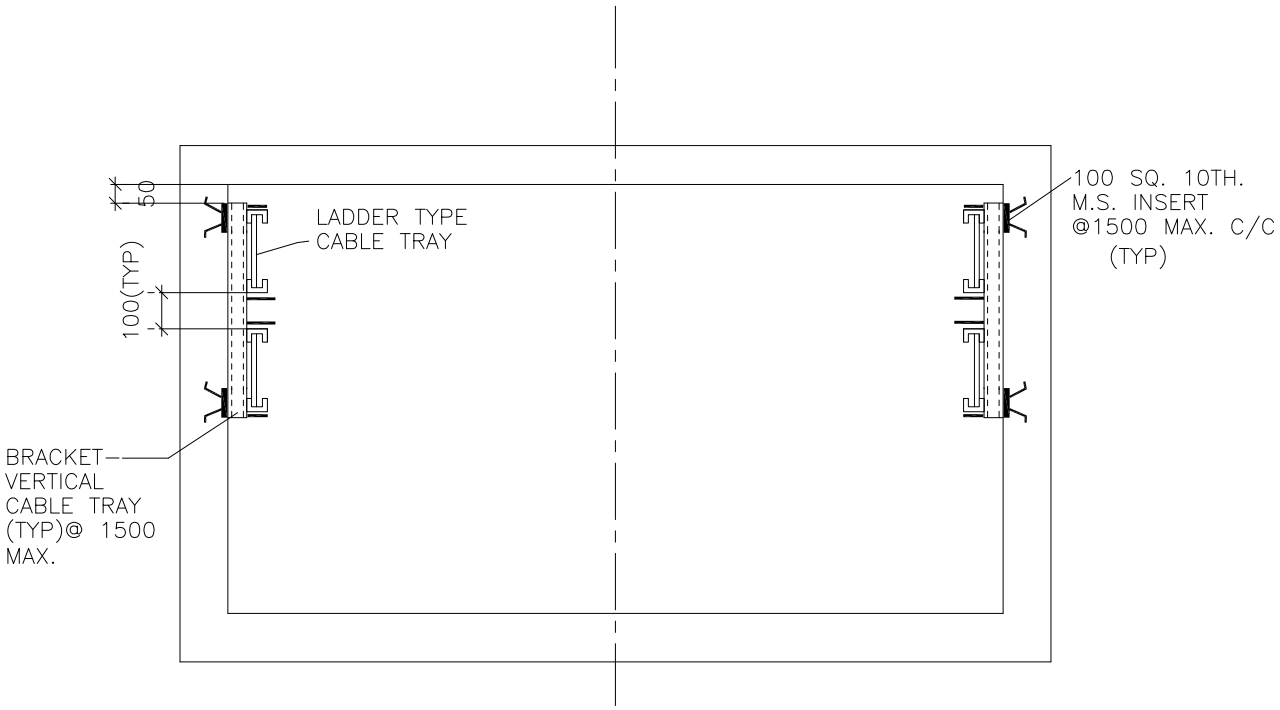
MOUNTING ARRANGEMENT

(IN CONVEYOR TUNNEL–ALT–II)

NOTE:–

ALL DIMENSIONS ARE IN MM.

BHEL	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE–DG–417–507–E006 REV. 05 SHT. 13 OF 15



TYPICAL VERTICAL ARRANGEMENT

NOTE:–

ALL DIMENSIONS ARE IN MM.

	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE–DG–417–507–E006
		REV. 05 SHT. 14 OF 15

NOTES:–

1. ALL DIMENSIONS SHOWN ARE IN MM.
2. CABLE TRAYS SHALL BE SUPPORTED @ 1.5M FOR HORIZONTAL RUNS & @ 1M FOR VERTICAL RUNS (E.G. RISERS).
3. CABLE TRAYS SUPPORTING STRUCTURE SHALL BE FABFRICATED AT SITE OUT OF HOT–DIP GALVANISED STRUCTURAL MEMBERS (ISMC/ISA) AS PER REQUIREMENT. AND SHALL BE WELDED TO STRUCTURAL STEEL(WHERE AVAILABLE), OR INSERT PLATES PROVIDED ALONG FLOOR SURFACES/WALLS/BOTTOM OF CEILING.
4. MINIMUM DEPTH REQUIREMENTS FOR TRENCHES ARE INDICATED. SLOPE DETAILS SHALL BE TAKEN CARE OF IN CIVIL DRAWING.
5. CABLE TRENCH TYPES SHALL BE AS UNDER:–
   a)TYPE–A – SINGLE TRAY, SINGLE SIDE
   b)TYPE–B – DOUBLE TRAYS, SINGLE SIDE
   c)TYPE–BB – DOUBLE TRAYS, BOTH SIDES
6. GALVANISATION DAMAGED DUE TO WELDING SHALL BE MADE GOOD WITH APPLICATION (2COATS) OF COLD GALVANISING ANTI CORROSIVE PAINT.
7. NUMBER OF TIERS ARE VARIABLE AS PER THE REQUIREMENT & SHALL BE SHOWN IN RESPECTIVE CABLING LAYOUT DRAWINGS.
8. CABLE TRAYS SHALL GENERALLY BE INSTALLED IN HORIZONTAL ORIENTATION.
   IN AREAS SUSCEPTIBLE TO COAL/ASH DUST DEPOSITION (E.G OVERHEAD CABLING PATHS IN BOILER AREA, TRAYS BELOW BOILER PLATFORMS ETC.) CABLE TRAYS SHALL BE INSTALLED IN VERTICAL ORIENTATION.
9. PERFORATED TYPE HOT ROLLED MILD SHEET OF 14 GAUGE (2MM THICK) COVERS SHALL BE USED FOR VERTICAL CABLE SHAFTS UPTO A HEIGHT OF 2.5 METERS FROM FLOOR LEVEL.
10. FOR CABLING NOTES AND DETAILS REFER DRAWING NO.PE–DC–417–507–E004 R3 △4
11. ALL STEEL MATERIAL IS GALVANISED. △1
12. FIRE STOP ARRANGEMENT AND DRAWING ARE DEPENDENT ON VENDOR DRAWING /DOCUMENT. IT SHALL BE INDICATED IN FIRE SEALING VENDOR DRAWING.. △5

भा एड इ प्ला BHEL	TYPICAL DETAILS OF CABLE TRAY SUPPORT SYSTEM	DWG. NO. PE–DG–417–507–E006
		REV. 05 SHT. 15 OF 15

SECTION: I

SUB-SECTION: C4

TECHNICAL SPECIFICATION (C&I PORTION)

C&I SPECIFICATION
FOR
AIR CONDITIONING (AC) SYSTEM

INDEX

INDEX

1. SPECIFIC TECHNICAL REQUIREMENT
2. DRIVE CONTROL PHILOSOPHY
3. ACTUATOR SPECIFICATION
4. ACTUATOR DATA SHEET
5. INSTUMENT DATASHEET
6. PLC SPECIFICATION WITH DATA SHEET, CONFIGURATION DRAWING, QUALITY PLAN
7. ERECTION HARDWARE
8. KKS PHILOSOPHY
9. LCP AND JUNCTION BOX SPECIFICATION WITH QUALITY PLAN
10. CABLE BOQ
11. INSTRUMENT STUB DETAILS

SPECIFIC TECHNICAL REQUIREMENT

1. **The bidder shall provide complete Instrumentation, control system for control, monitoring and operation of Air Conditioning Plant.** The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre bid clarification. In absence of any pre bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial and time implication.

2. **Air Conditioning Plant along with ventilation system (through separate contract)** shall be operated & controlled from common stage-wise PLC based control system with interface with plant DCS. Operation & Control of HVAC plant is envisaged through PLC/RIO's panels mentioned below which are placed at different locations.:

   Stage # 1
   - **Stage I (Unit 1 & 2) PLC panel to be placed in Stage # I - AC plant control room located at ground floor of CCR/CER (Unit # 1 & 2).**
   - **Stage I (Unit 1 & 2) RIO panel to be placed in FGD Stage I Control Room. This**
   - **RIO panel will be hooked up with stage I PLC panel.**

   Stage # 2
   - **Stage II (Unit 3, 4 & 5) PLC panel to be placed in Stage # 2 - AC plant control room located at ground floor of CCR/CER (Unit # 3 & 4).**
   - **Stage II (Unit 3, 4 & 5) RIO panel to be placed in FGD Stage II Control Room.**
   - **This RIO panel will be hooked up with stage II PLC panel.**

   Common RIO's to be hooked up with both PLC's i.e., stage I & stage II PLC panels

   - **Common RIO panel to be placed in Switchyard control room and hooked up with both stagewise PLC's.**
   - **Common RIO panel to be placed in DM Plant Control room and hooked up with both stagewise PLC's.**

   Tentative I/O's count for Ventilation system (AHU and UAF's) is annexed.

3. A common, stagewise PLC based control system cum Annunciation panel with solid state annunciation windows along with product integrated microprocessor panel for the chilling unit shall be provided for the operation of Air Conditioning and Ventilation system by the AC system vendor.

4. PLC shall have redundancy at processor (HOT STANDBY), power supply, communication system.

5. PLC shall have the facility to synchronize its time with BHEL supplied GPS.Necessary Hardware (IRIG-B port) for same at PLC end to be provided by bidder. The cable connecting PLC and GPS shall be in BHEL scope.
6. Redundant PLC communication shall be provided for communication between PLC and DCS through serial link with OPC Compliant for monitoring /Control. For detail, please

refer PLC Architecture Diagram. Separate OPC servers with required hardware/software to interface with main plant DCS shall be provided.

7. **Following is the HMI requirement**
   - **1 no. OWS to be placed in main control room CCR1**
   - **1 no. OWS to be placed in main control room CCR2**
   - **1 no. OWS to be placed in main control room CCR3**
   - **2 no. OWS, 1 no. OEWS and 1 no. A3/A4 printer to be placed in local control room (LCR) stage #1**
   - **2 no. OWS, 1 no. OEWS and 1 no. A3/A4 printer to be placed in local control room (LCR) stage # 2**
   - **1 no. OEWS to be placed in FGD 1 control room.**
   - **1 no. OEWS to be placed in FGD 2 control room.**
   - **1 no. OEWS to be placed in Switchyard control room.**
   - **1 no. OEWS to be placed in DM Plant control room.**
   - **1 no. Laptop for each Stage PLC.**

8. **Redundancy of sensors shall be provided, irrespective of instrumentation shown in the PID, by bidder as per following:**
   (i) Triple redundancy for all analog and binary inputs required for protection of system /drives.
   (ii) For all other control functions & alarms, dual redundancy of the sensors shall be provided by the bidder.

9. Supplied system shall provide group alarms to be hardwired to plant DCS.Same shall be discussed during detail engineering.

10. Redundant Uninterrupted Power Supplies (UPS in BHEL scope) with adequate rating of continuous duty with backup shall be provided for the stage wise PLC system, RIO Panels, HMI at each location based on the load data provided by the bidder.
    Redundant non-UPS supply feeder 415 V, 3 phase, AC supply shall be provided by BHEL based on the load data provided by the bidder.Necessary redundant ACDB's shall be considered and provided by bidder at each location.
    UPS is not in BIDDER's scope.

11. 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.

12. All the instruments shall be supplied along with necessary fittings, accessories, valve manifold, root valves, Junction box, Canopy & Structural steel as required. Instrument Installation along with hardware shall be in bidder scope. Double root valves shall be provided where pressure is above 40 Kg/cm2.

13. The solenoid operated valves/ damper/gates shall have limit switches for open/ close feedback. Solenoid valve shall be rated for 24 V DC only.

14. The junction boxes/LIEs for termination of instruments /solenoid valve limit switches etc. are in bidder's scope. All instruments shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope.

15. Enclosure class of all transmitters & electronics items including JBs shall be explosion proof.

16. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

17. All necessary instruments such as transmitters/temperature elements/sensors/switches/gauges etc. shall be provided for safe, efficient & reliable operation and maintenance of the air conditioning plant.

18. Transmitters shall be provided instead of switches.

19. All Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.

20. As a general rule, measuring points and measuring equipment for critical protection shall be separate from and not combined with measuring equipment for the automatic control equipment.

21. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.

22. 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.

23. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

24. 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.

25. Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no instruments / analyzers & JBs/Racks should be protruding on the walkway.

26. Each valve/instrument shall be fitted with a stainless steel or aluminum nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

27. The equipment shall be of modern, compact design incorporating the latest developments in proven technology.

28. Solenoid valves shall be kept in pneumatic junction boxes only. Air distribution for SOV's shall be through SS manifold with SS isolation valves and auto drain traps and SS tubing from SOV to valves shall not be more than 6 meters.

29. All furniture (tables, chairs etc.) required for PLC operator HMI shall be in bidder's scope. Chairs shall be capable of being adjusted for height and position of backrest. One table and chair shall be provided for each operator station and separate table for each printer.

30. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.

31. All the instruments/equipment/electrical items shall be provided & designed with maximum star rating in line with energy conservation policies as per latest international standards at the time of supply.

32. Bidder to provide erection hardware including canopies, structural steel as required.

33. Bidder to perform tests of C&I items/instruments/systems as per quality plans/type test attached in the specification.

34. 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.

35. Each valve/instrument shall be fitted with a stainless steel or aluminium nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

36. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

37. Mandatory spares have to be supplied by bidder as mentioned in the specification.

38. The specifications for instruments mentioned in the specification are minimum requirements. Datasheets of instrument shall be subject to customer/owner approval.

39. Editable & pdf copy of Drawings/Documents and data to be furnished after award of the contract:

- Local Control room drawing
- GA & wiring diagram of local panel.
- PLC configuration diagram.
- Local control panel & instruments data sheet.
- Control & operational write-up for the system
- Control scheme/ logic diagram
- List of Drives (Solenoid valves etc.)
- I/O list
- Power requirement.
- JB grouping document.
- Cable schedule and cable interconnection drawing.
- Instrument schedule
- Alarm Schedule
- SOE schedule
- Instrument hook-up diagram.
- Mandatory spare BOQ
- UPS load list
- Any other document decided during detailed engineering.

Notes:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.

2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.

IO COUNTS FOR VENTILATION SYSTEM

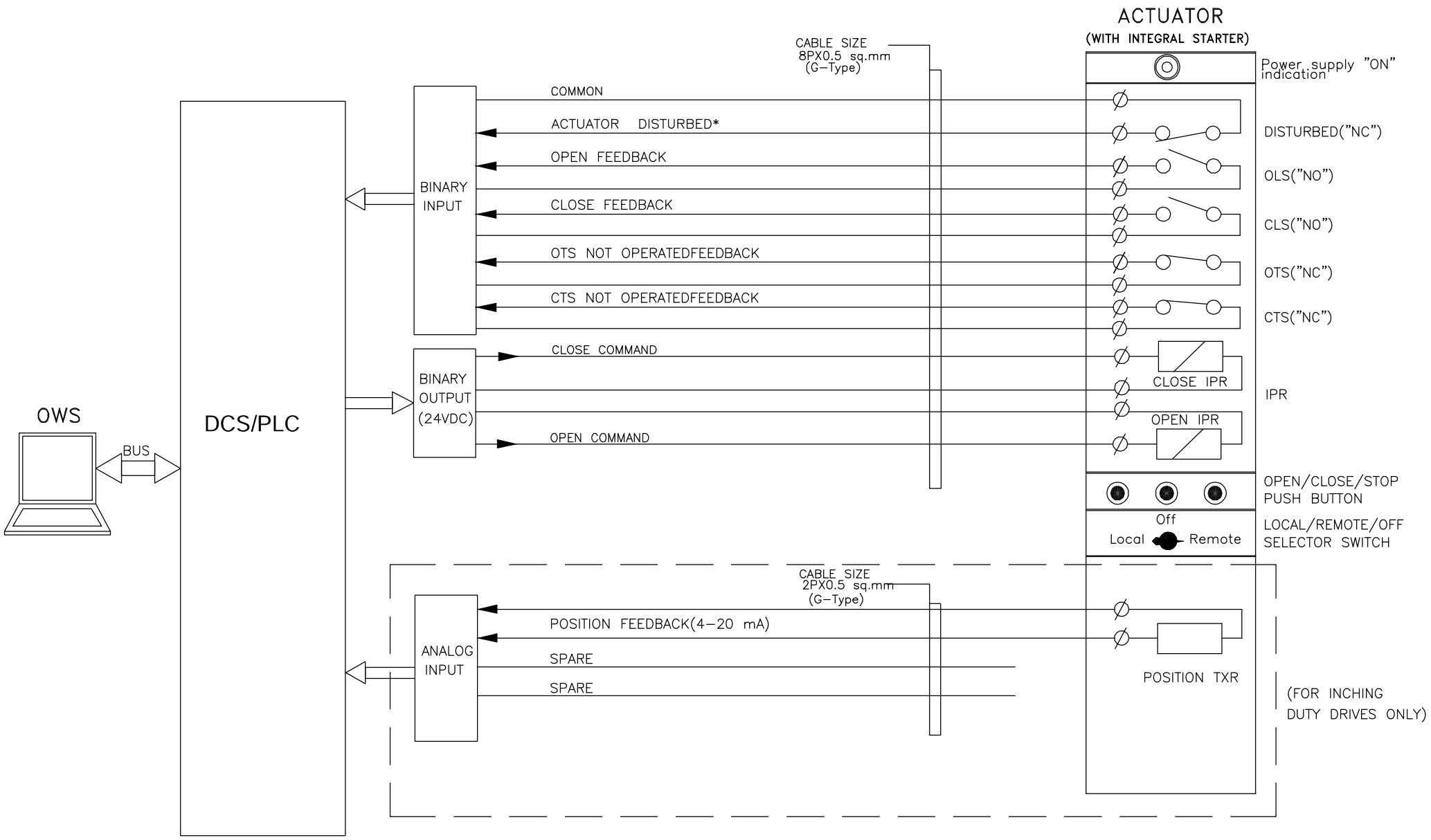
	Ventilation		Ventilation (drive)		
STAGE#1	DI	AI	DI	DO	AI
Main Power House	90	20	330	180	85
Service Building	0	0	0	0	0
ESP Building #1	20	5	160	60	35
ESP Building #2	20	5	160	60	35
FGD Building	20	5	160	60	35
STAGE#2					
Main Power House	150	30	550	220	120
Service Building	0	0	0	0	0
ESP Building #3	20	5	160	60	35
ESP Building #4	20	5	160	60	35
ESP Building #5	20	5	160	60	35
FGD Building	20	5	160	60	35
COMMON					
DM Plant	0	0	0	0	0

Note: The above list of IO counts is for ventilation system and for estimation purpose only. The final IO count may vary in the range of +/- 20 %. Additional IO's if required for the ventilation system shall be provided by the successful bidder without any cost and delivery implication to BHEL. The spares IO shall be considered separately in line with the requirement of technical specification.

The IO's for the AC system shall be derived by the bidder inline with the requirements of the technical specification.

Drive Control Philosophy

DCS INTERFACE FOR BIDIRECTIONAL DRIVE (WITH INTEGRAL STARTER)

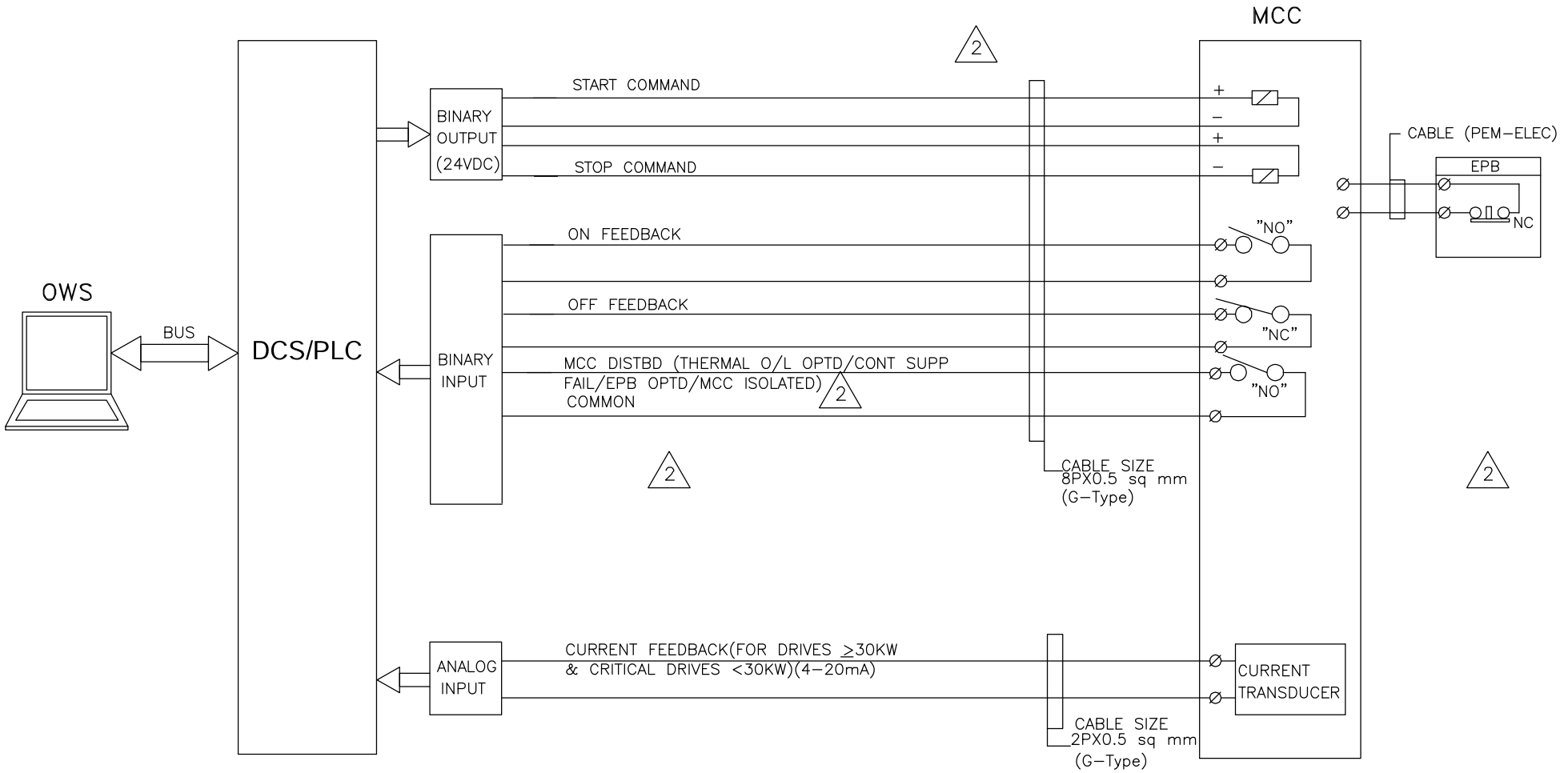


NOTE:

* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/ Thermal over load/Torque open/close cutoff Local/Off/Remote Sel. switch Stop PB optd.

BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE-DM-417-145-I002
		DATE	06.12.2019
	TITLE: DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	03
		SHT	7 OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



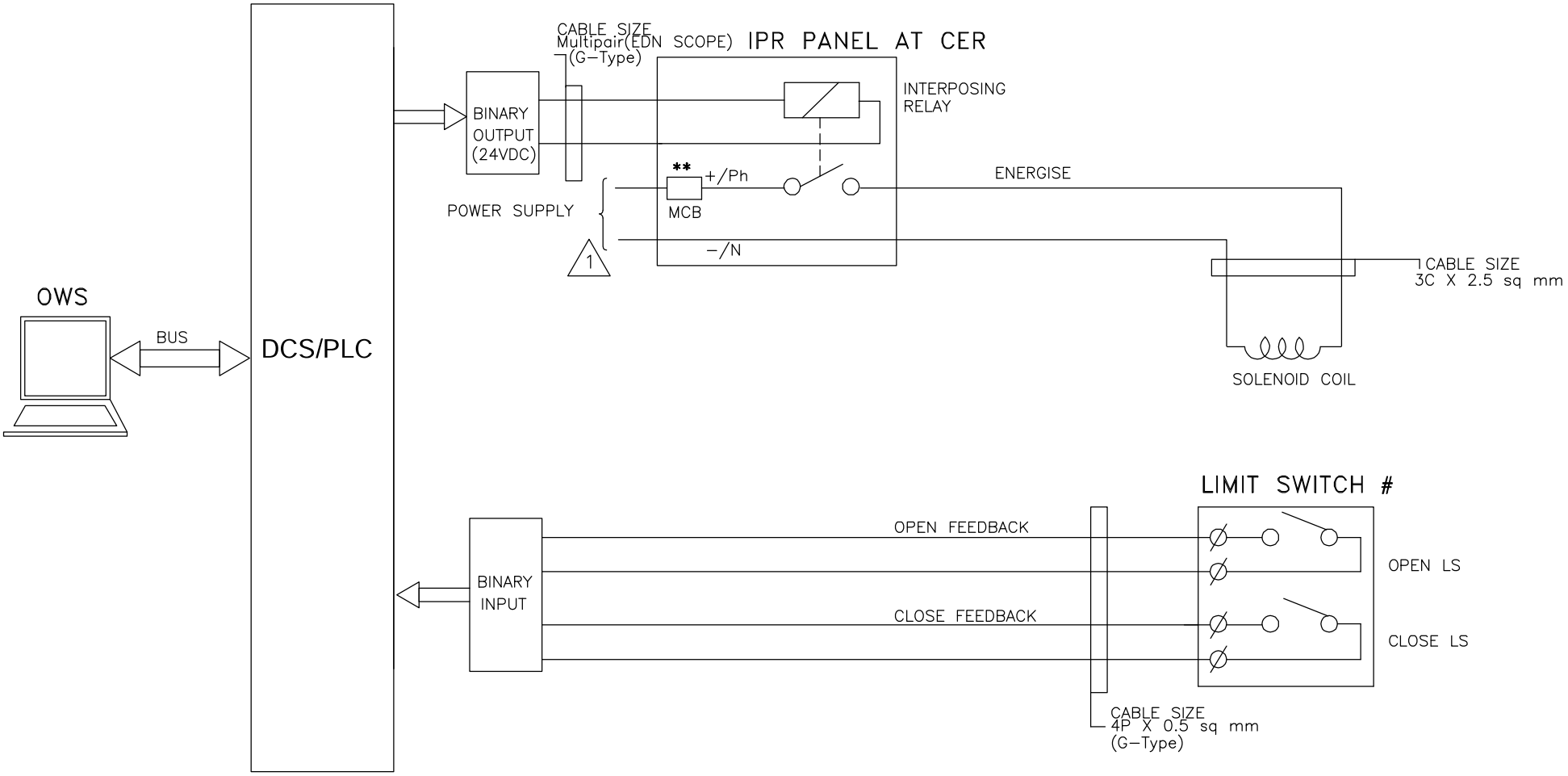
NOTE:–

1) EPB OF RESPECTIVE DRIVE WILL BE MOUNTED NEAR TO DRIVE ONLY. (1)

2) 4–20mA CURRENT TRANSDUCER SHALL BE CONSIDERED. FOR LTUDs >30 KW AND IMPORTANT DRIVES, LUBE OIL PUMPS (REFER CLAUSE D, SHEET 6 OF 11) (2)

BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO. PE–DM–417–145–I002
		DATE 06.12.2019
	TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO. 03
		SHT 8 OF 11

DCS INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS)



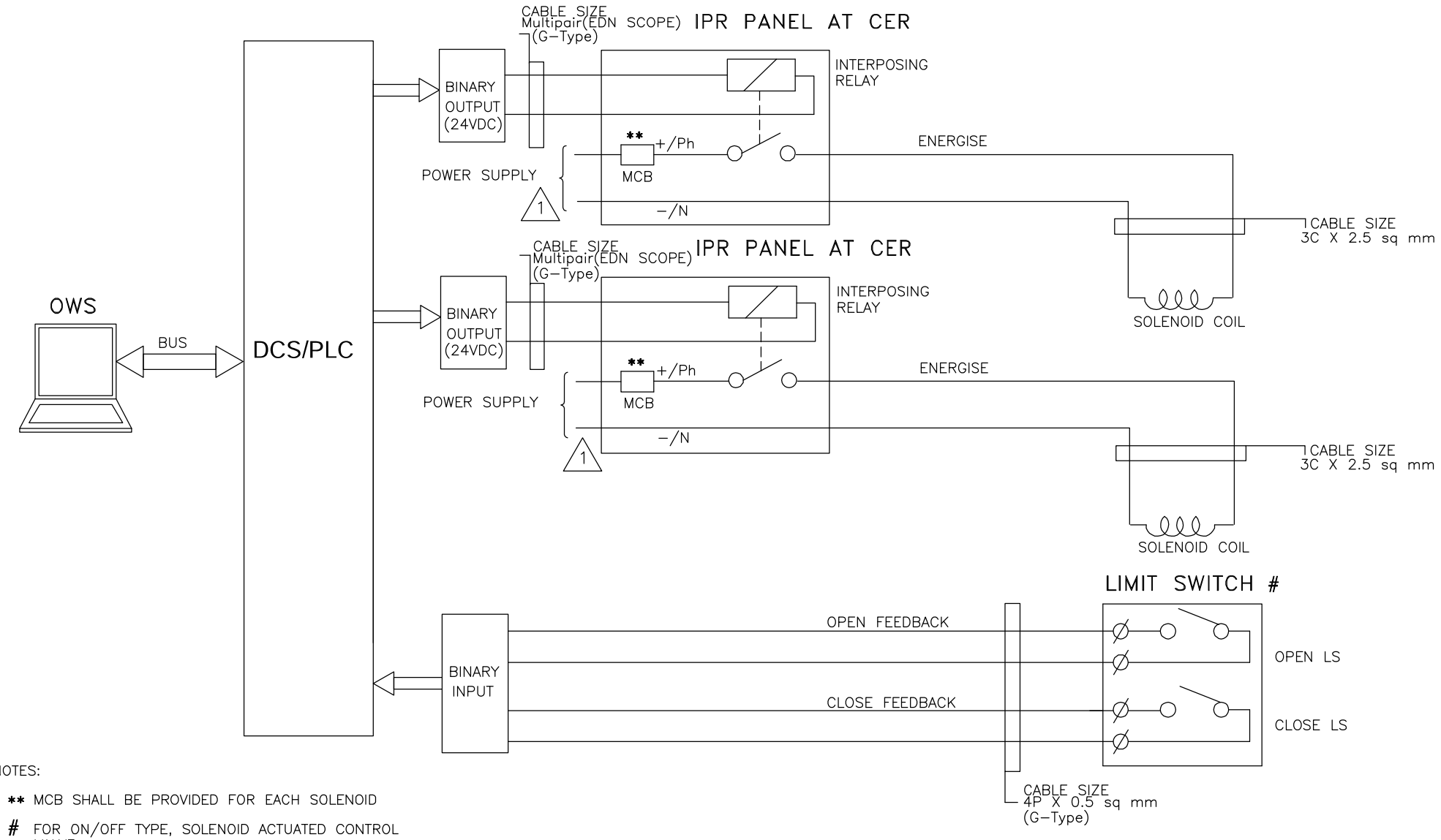
NOTES:

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO. PE-DM-417-145-I002
		DATE 06.12.2019
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE (SINGLE COIL)	REV.NO. 03
		SHT 9 OF 11

DCS INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS)



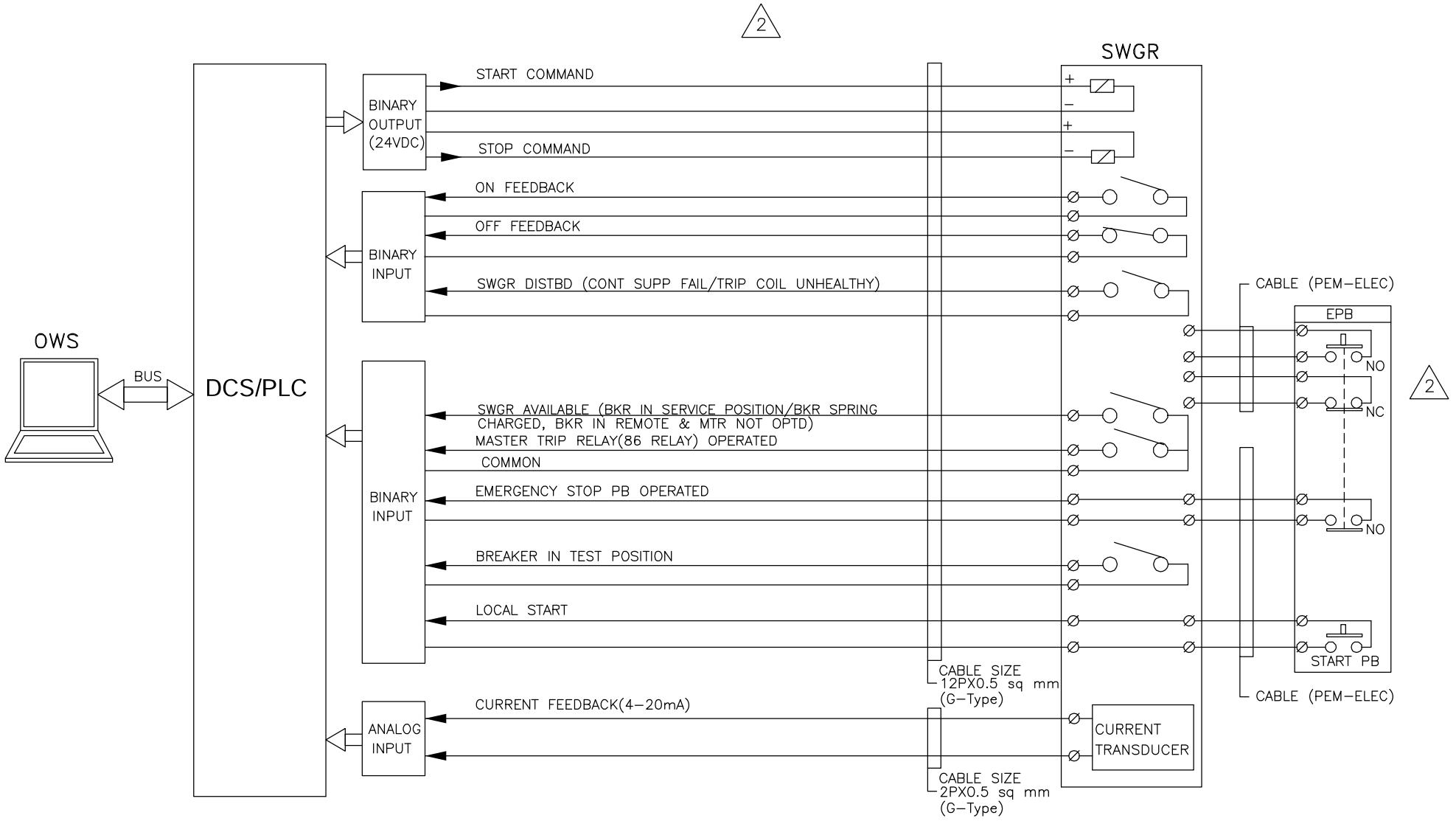
NOTES:

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO. PE–DM–417–145–I002
		DATE 06.12.2019
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE (DOUBLE COIL)	REV.NO. 03
		SHT 9a OF 11

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)

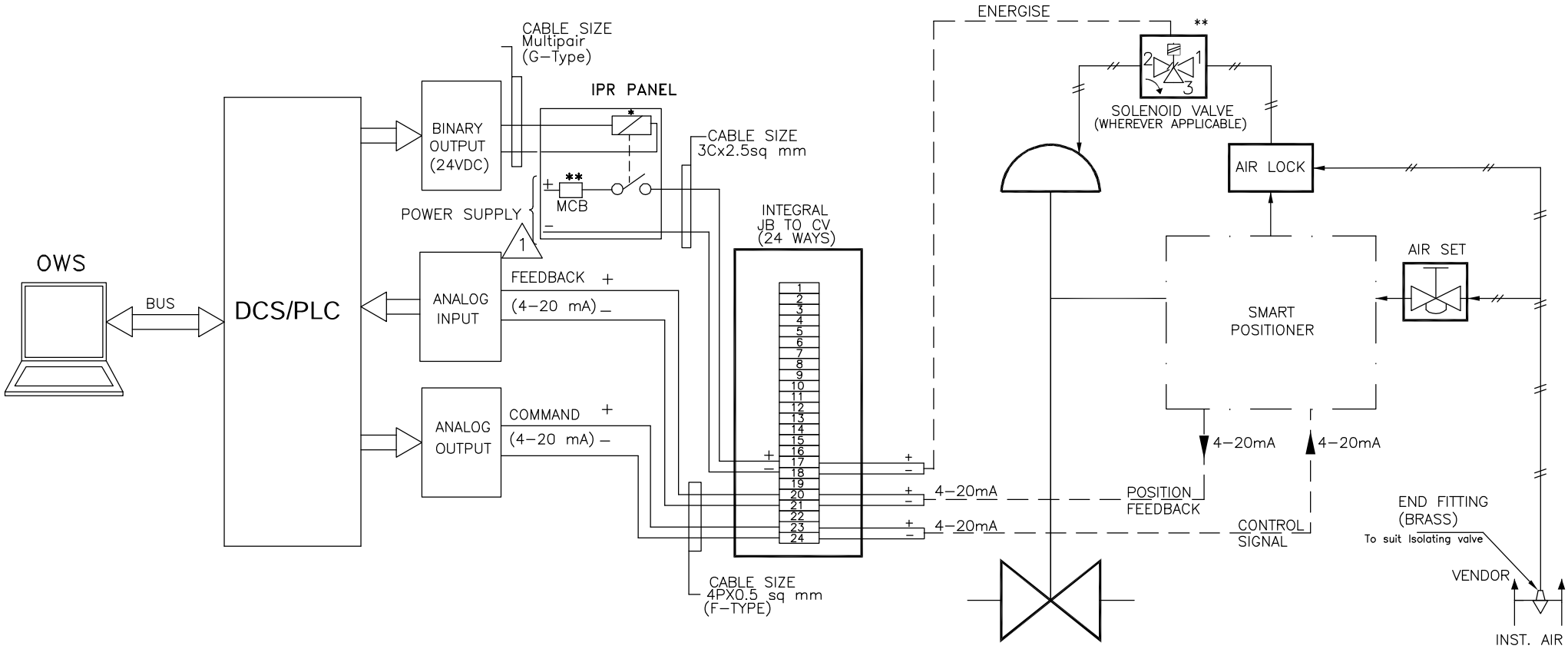


NOTE:-
EPB OF RESPECTIVE DRIVE WILL BE MOUNTED NEAR TO DRIVE ONLY.

1

PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE-DM-417-145-I002
	DATE	06.12.2019
TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	03
	SHT	10 OF 11

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.

BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE–DM–417–145–I002
		DATE	06.12.2019
	TITLE: TYPICAL HOOK–UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER)	REV.NO.	03
		SHT	11 OF 11

ACTUATOR SPECIFICATION

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

1.00.00 SCOPE

1.01.00 This Section covers the general requi rements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accord ance with this general specification and the accompanying driven equipment specification. A ll the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, ex cept when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part ev en if not covered in the listed standards shall also be followed

i) IS -9334

ii) IS-325

3.00.00 SERVICE CONDITIONS

3.01.00 The actuator shall be suitable for operation in ho t, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electric al equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in t he d etermination of the design ambient temperature.

4.00.00 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For reg ulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 **PERFORMANCE**

The actuator shall meet the following performance requirements:

5.01.00 Open and close the valve completely and make leak-tight valve closu re without jamming.

5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).

5.03.00 Operate the valve st em at st andard stem speed and shall function against design differential pressure across the valve seat.

5.04.00 The motor reduction g earing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit sw itches or from lodging of foreign matter under the valve seat.

6.00.00 **SPECIFIC REQUIREMENT**

6.01.00 **Construction**

6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.

6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.

6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 **Motor**

6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.

6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.

6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated v oltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.

6.02.04 Motor leads shall be terminated in the limit switch compartment.

6.02.05 Motor actua tors for valves/dampers shall be with inte gral starter with 3phase/3wire, 415V AC and operable from remote.

6.02.06 Earthing terminals shall be provided on either side of the motor.

6.03.00 **Limit Switches**

Each actuator shall be provided with following limit switches: -

6.03.01 2 torque limit switches, one for eac h direction of travel, self-locking, adjustable torque type.

6.03.02 4 end-of-travel limit switches, two for each direction of travel.

6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.

6.03.04 Each limit swit ch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.

6.04.00 **Hand Wheel**

Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutc h automatically when the moto r is energized.

6.05.00 **Position Indicator/Transmitter**

The actuator shall have:

6.05.01 One (1) built-in local position indicator for 0-100% travel.

6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.

6.06.00 **Space Heater**

A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.

6.07.00 **Wiring**

All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100 V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. A ll the electrical actuators shall have uniform wiring.

6.08.00 **Terminal Box**

The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.

7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

7.01.00 One (1) triple pole MCCB

7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.

7.03.00 One (1) remote-local selector switch.

7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.

7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 **TEST**

The actuator and all components there of shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 **To be submitted with Bid**

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz Effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW upto less than 175kW.
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%.
Combined Volt + frequency	:	10% (absolute sum)

During starting of large 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.

D.C. Supply :

Voltage : 187 to 242

Actuator Data Sheet

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO. : PE-ID-417-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 00	DATE:15/05/2019
		SHEET 1 OF 4	

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

GENERAL*	* PROJECT	**5 X 800 MW YADADRI TPS, NALGONDA**	
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ** ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.**	
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) DRG. NO. 3-V-MISC-24227 R00	
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ …….	
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ☐ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ IP 68 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)	
INTEGRAL STARTER	INTEGRAL STARTER	■REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS	
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART (REFER BELOW POINT a – h)		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■REQUIRED ☐ NOT REQUIRED	
	STOP PB	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL(Refer Note 14)	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY,)	
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	☐STAYPUT ☐ FAIL SAFE	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) **DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED**	TYPE OF ISOLATING DEVICE	■ INTERPOSING RELAY ☐ OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING	
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
Actuator) **($$ Refer Notes)**	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	
	ACCURACY	2% OF SET VALUE	

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@☐ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET	☐ REQUIRED ☐ NOT REQUIRED	
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)		
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	CONTROL CABLE GLANDS-1	INSTRUMENT CABLE SIZE FOR ON/OFF DUTY VALVES SHALL BE 8PX0.5 SQMM. ONE CABLE GLAND OF OD SIZE 20 MM. INSTRUMENT CABLE SIZE FOR INCHING DUTY TYPE VALVES SHALL HAVE TWO NO. CABLES (ONE NO. 8PXO.5 SQMM AND 2ND 2PXO.5 SQMM) - TWO NO. GLANDS OF OD SIZES 20 MM & 15 MM.	
	CONTROL CABLE GLANDS-2		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
7. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.
8. IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
9. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
10. LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
11. CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
12. ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
13. TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
14. INTEGRAL STARTER/ACTUATOR DISTURBED SIGNAL SHALL BE CHECKED AND INCLUDE AS PER DRIVE CONTROL PHILOSOPHY.
15. **** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM ETC SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

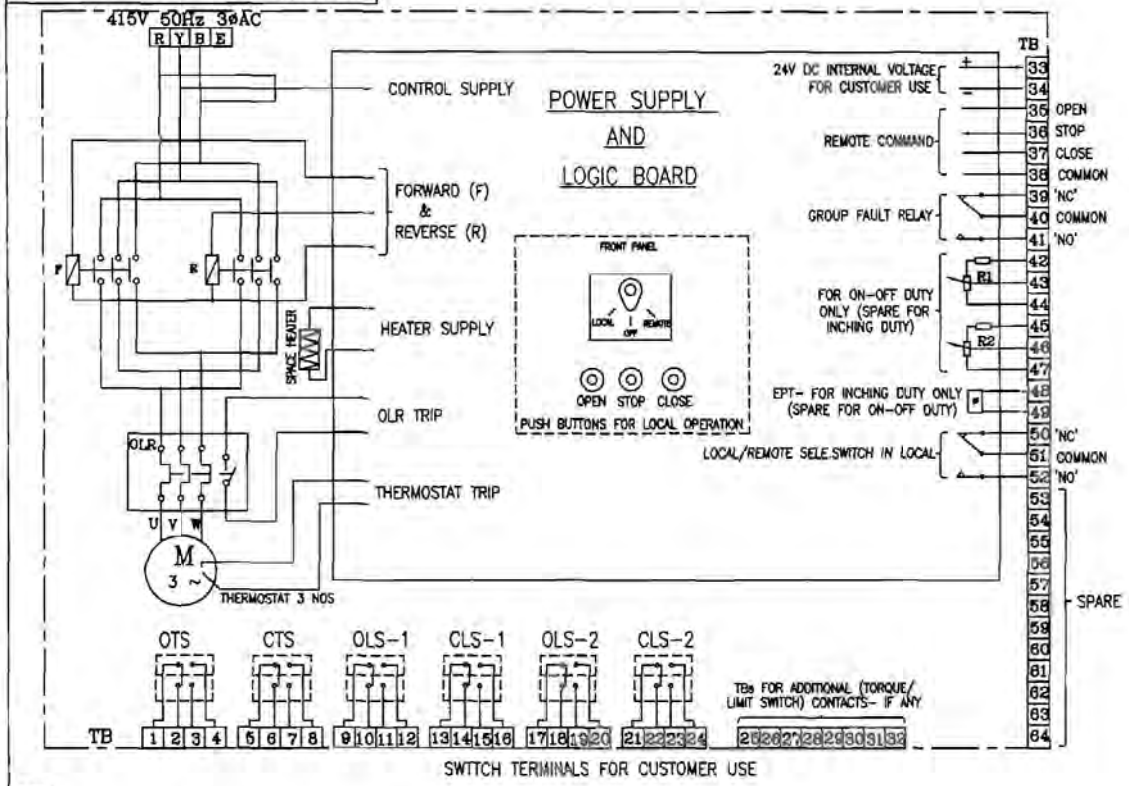
EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	RINKY	RAVINDER K RAINA	SHIVRAJ SINGH BANSALA	NAME
SIGNATURE				SIGNATURE
DATE	15.05.2019	15.05.2019	15.05.2019	DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

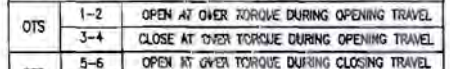
DRAWING NO. 3-V-MISC-24227



SWITCH TERMINALS FOR CUSTOMER USE

CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	



INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

- CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:-

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
2. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
5. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
6. EPT - ELECTRONIC POSITION TRANSMITTER (CONTACTLESS TYPE, FOR INTCHING DUTY)
7. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M - MOTOR 3ø 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	07.10.04	
CHD	D.DINAKARAN	D.D	07.10.04	
APPD	K.ARUNACHALAM	K.A	07.10.04	

DEPT VL | CODE | SCALE | WEIGHT (KG). | REFERENCE INFORMATIONS | NO. OF SHEET

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24227

REV: 0

Size A3

INSTRUMENTATION DATA SHEET

VOLUME : VI
SECTION-VII
SUB SECTION - B
CONTROL VALVES

1.00.00 **GENERAL**

1.01.00 Control valves for regulating service shall normally be globe body, preferably cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs

1.02.00 Where high stroking speed , high actuation forces and accurate positioning is critical for the operation of the plant, as in case of HP or LP bypass valves, Separator Drain Valves , hydraulic actuators with electro-hydraulic interface shall be offered.

2.00.00 **GENERAL TECHNICAL REQUIREMENTS**

2.01.00 Bidder shall exercise caution in selecting severe service control valves like BFP recirculation, HP & LP bypass, superheater & reheater attemperator, PRDS for Boiler & Turbine, Feed control station ,Soot blower steam pressure, Fuel oil heating and pressurizing ,minimum economizer flow control ,DM make up (emergency / normal), control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water, separator level control , CEP minimum flow control etc. For such critical applications, Bidder shall offer valves which are proven for similar application. Above valves shall have leakage class equal or better than class-VI with metal-to-metal seating.

2.02.00 Valve with ANSI leakage class-V shall be provided for all applications except for the control valves indicated above.

2.03.00 Bidder shall provide redundant control valves for some services such as Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.

2.04.00 Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream motorized isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream motorised isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.

2.05.00 Wherever, steam conditioning calls for , Pressure reducing & desuperheating, combined PRDS type valves shall be offered.

2.06.00 Control Valve shall be furnished with IBR certification wherever required .

2.07.00 Valve Body / End Connections

2.07.01 Valve end to end dimension and connection shall be according to ANSI standard, straight through pattern. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to inlet pressure.

2.07.02 Control valves of 40 mm. size and above with line pressure up to 50 Kg / Sq. cm may have flanged or welded end connections.

2.07.03 Control valves, used in high pressure services shall have butt welded end connections for size 65mm and above and socket weld end connection for size 50 mm or below.

2.07.04 Control valve body shall be selected as per the ISA GUIdeline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application, valve body shall be Stainless Steel.

2.07.05 Bonnet joints for all control valves shall be of flanged and bolted type.

2.07.06 Flanged valve shall be rated at no less than class 300 lbs

2.07.07 The direction of flow shall be clearly engraved on the body . Valve tag no, , description or purpose, stroke time shall be painted on all control valve body with black letters on white background in Bold letters.

2.07.08 Valve Body Materialial shall match the process conditionrequirement as per ANSI. . General guideline shall be as follows

SR. NO.	SERVICE		MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature up to 275ºC	:	Cast carbon steel ASTM A216 Gr. WCB , Trim material - 316 SS stellited faced GUIde posts and bushings.
2.	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275ºC	:	Cast alloy steel ASTM A217 Gr. WC9 Trim material - 316 SS stellited faced GUIde posts and bushings.
3.	Severe flashing / cavitating services	:	Alloy steel ASTM A217 Gr. WC9 , Trim material - 440C
4.	Low flashing / cavitating services	:	Alloy steel ASTM A217 Gr. WC6 ,Trim material - 17-4 PH SS
5.	DM water application (condenser hotwell normal, emergency make up etc.)	:	316 stainless steel

2.07.09 Bidder may supply valves with body and trim materials with superior quality than specified material and in such cases Bidder shall furnish the comparison of offered material properties ,such as cavitation resistance , , hardness , tensile strength , strain energy , corrosion and erosion resistance etc. , with specified material for Owner's approval.

2.08.00 Valve Size

The control valve sizing (Cv / Kv) shall be based on following guidelines :

a) The valves shall pass normal flow (MCR condition) with 60 to 70 percent opening for linear characterised valves and between 70 to 80 percent opening for equal percentage characterised valves.

b) The valves shall have adequate rangeability to pass the minimum and maximum flows at 10% and 85% of the valve opening respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.

c) Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required maximum flow.

d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.

e) Trim exit outlet velocity as defined in ISA handbook does not exceed 8 m / sec for liquid services , 150 m/sec for steam services anf 50/% of sonic velocity for flashing services The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.

2.09.00 Valve Top work

2.09.01 Top work shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.

2.09.02 Extended bonnet/ bonnet when maximum temperature fluid is greater than 280^0 C shall be provided and high temperature packing shall also be used for high temperature application.

2.09.03 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for lower temperature application (232°C maximum) and for high temperature application graphited asbestos glands are to be provided. For vacuum services,. All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications eg. double vee type chevron packing.

2.10.00 Valve Trim

2.10.01 Valve trim for applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/ Sq. cm. For pressure drops above 7 Kg/Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys or treatment such as nitride shall be used if severe erosion is expected.

2.10.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators.

2.10.03 For flashing services and two stage mixtures, the trim material shall be 17-4 PH SS or equivalent.

2.10.04 If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trims valves. Trim of severe service valves shall be of multistage and multipath design with number of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.

2.10.05 Quick replacement type trim shall be considered for easy maintenance.

2.10.06 Plug shall be one-piece construction cast , forged or machined from solid bar stock .Plug shall be screwed or pinned to valve stems or shall be integral with the valve stems.

2.11.00 Noise Level

The equivalent sound level measured at 1.5M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dBA. The noise abatement shall be achieved by valve body & trim design and not by use of silenecers. Valve Actuators

2.12.00 Actuator

2.12.01 Spring-diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Hydraulic actuation system shall be provided for Critical valves as described elsewhere in the specification.

2.12.02 The actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.

2.12.03 Diaphragms shall be designed for 200% maximum operating pressure.

2.12.04 Nylon reinforced neoprene is preferred as diaphragm material.

2.12.05 Valve actuators shall be capable of operating at 80^0 C ambient, continuously.

2.12.06 Entire actuator assembly shall be painted with corrosion inhibiting paint.

2.12.07 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be stainless steel.

2.12.08 Bidder shall indicate the stroking time of the valve assemblies with ositioned and ensure that the stroke time shall meet the process and equipment dynamics and shall be better than 10 seconds.

2.12.09 All actuators shall be of fail safe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.

2.12.10 Hydraulic actuation system

The system shall consist of , but not limited to , Hydraulic cylinder , proportional valve with blocking unit , SMART positioner with position transmitter , SOVs , safety bypass unit , safety control unit , Hydraulic supply unit and local controller cubicle with controller unit

2.13.00 Valve Positioners

2.13.01 All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response.

2.13.02 Positioners shall have integral non contact type position transmitter, input and output gauges, local keypad & display and 4-20 mA DC output to DDCMIS in CCR.

2.13.03 Positioners shall be capable of functioning under hot, humid and vibrating conditions.

2.13.04 Positioner casings shall be dust tight, corrosion resistant and weatherproof to IP 65 .and explosion proof in hazardous areas.

2.13.05 In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required.

2.13.06 Remote calibration from control room shall be possible through HART management station.

2.14.00 Performance

2.14.01 Performance of the complete assembly of the control valves shall be better than +/- 1% of FS for linearity , +/- 0.5 % of FS for hysteresis , 1% for accuracy.

2.15.00 Valve Accessories

2.15.01 Accessories shall include side mounted hand wheels, open & close , intermediate (as applicable) limit switches for both regulating and On off valves ,, junction boxes with 20 % spare terminals , Air filter regulators , airlock relays , volume chambers etc. Solenoid valve (SOV) wherever required shall be furnished. Each limit switch shall have not less than 2 NO & 2 NC contacts with contact rating 5A , 240 V AC / 0.5 A , 220 V DC . SOV shall have SS bar stock body , SS316 Trim , SS coil enclosure , Class H insulation Air filter regulator shall have sintered bronze filter element with maximum 5 microns filter size & 2 inch dial size pressure gauges. .Protection class of all Limit switches , junction boxes , SOV etc. shall have protection class IP 65 and explosion proof for hazardous areas.

2.15.02 Air distribution line to all final control elements like control valves, pneumatic dampers (both regulating / on-off type) , SOV operated valves shall be through SS manifolds and SS isolating valves only. These valves shall be properly tagged also with KKS tag no. and description of final control element / instrument for which they are intended.

2.16.00 Test and Examination

All valves shall be tested in accordance with the Quality Assurance programme agreed between the Owner and Bidder , which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specification . The test shall include but not be limited to Non destructive test , Hydrostatic shell test prior to seat leakage test , Seat leakage test , Valve closure test , Functional test of fully assembled valves including actuators and accessories. CV test etc. For all control valves Cv test shall be witnessed by Owner.

1.00.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

1.01.00 PRESSURE TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm
5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:	:	
	i. Accuracy		±0.075% of Span or better

	ii. Repeatability		±0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts c. Siphon for steam and hot water services d. ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock e. Companion flange with nuts, bolts and gaskets f. ½" NPT cable gland g. Handheld calibrator
19.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

Notes: For primary air/ secondary air/ flue gas applications, DP type transmitters shall be provided for pressure measurement.

LVDT type is not acceptable.

1.02.00 DIFFERENTIAL PRESSURE TRANSMITTER / FLOW TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm

5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:		
	i. Accuracy	:	±0.075% of Span or better
	ii. Repeatability	:	±0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts

c. Siphon for steam and hot water services

d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock

e. Companion flange with nuts, bolts and gaskets

f. ½" NPT cable gland

g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

1. Type : Smart (HART Compatible)
2. Stages of operation : Continuous
3. Material :
4. i. Displacer SS-316
5. ii. Suspension wire SS-316
6. iii. Torque tube housing SS
7. iv. Torque tube Inconel
8. v. Displacer chamber SS
9. vi. Transmitter Housing SS
10. Operating Voltage : 24 V DC
11. Transmission : Microprocessor based, 2-wire
12. Output Signal : 4-20 mA DC along with superimposed digital signal
13. Static / overload : Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 ^{O}C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2" Flanged
22.	Performance - Accuracy	:	$\pm$ 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½" NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

26.	Applications	:	During detail engineering on Owner's approval

1.04.00 MASS FLOW METER

1.04.01 SENSOR

1.	Measuring Principle	:	Coriolis Mass flow
2.	Primary Element	:	Flow Tube of 316SS or better
3.	Heating Arrangement	:	Integral
4.	Temperature Control	:	For heavy fuel oil application
5.	Process Connection	:	Flanged of rating as per process requirement
6.	Drain	:	Self-draining facility
7.	Enclosure	:	Stainless steel
8.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

1.04.02 TRANSMITTER

1.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density
2.	Input Signal Processing	:	Smart (HART compatible)
3.	Display	:	LCD
4.	Output	:	2 nos. isolated output of 4-20mA DC selectable from four measured quantities
5.	Load	:	< 750 ohms
6.	Power supply	:	240V AC, 50 Hz

7.	Turn Down	:	100:1
8.	Accuracy	:	± 0.2 % of measured value
9.	Housing	:	IP 65 (Explosion proof)
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
11.	Accessories	:	a) Handheld calibrator b) Mounting U-bolts, nuts, bolts, prefab cable etc c) ½"NPT cable gland
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Fuel Oil service

1.05.00 RADAR TYPE LEVEL MEASUREMENT

1.	Type	:	Smart (HART Compatible)
2.	Antenna	:	Co axial / guided wave radar /Overspill protection
3.	Principle	:	TDR (Time Domain Reflectometry)
4.	Communication	:	Two wire 4-20mA DC with HART
5.	Environmental temperature	:	0 – 50 ºC
6.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
7.	Calibration	:	a) Self calibration with internal reference : b) Zero & Span calibration
8.	Process Connection	:	External cage mounting Flanged /screwed
9.	Electronic Housing	:	Epoxy painted Die-Cast aluminium

			alloy
10.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels

1.06.00 ULTRASONIC LEVEL TRANSMITTER

1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

9.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable. It shall be possible to calibrate the instrument without any level in the sump/ tank
10.	Accuracy & Repeatability	:	0.15 % of span or better
11.	Resolution	:	0.1 % of span
12.	Operating temp.	:	Transmitter- 500 C and Sensor - 800 C
13.	MOC Sensor	:	SS-316/Body- PVC and Face – Polyurethene
14.	Mounting	:	4" Flanged/ 2" NPT for sensor and Transmitter on panel
15.	Accessories	:	a) Handheld calibrator b) Weather canopy for protection from direct sunlight and direct rain c) ½"NPT cable gland d) All mounting hardware (SS-316), Prefab cable e) SS Nameplate
16.	Diagnosis	:	On-line
17.	Status Indication	:	Power On, HI, HI-HI, Lo, LO-LO, Fault
18.	Output Contacts	:	2 SPDT, 230V, 5A
19.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
20.	Applications	:	Coal Bunker, Water Service etc.

1.07.00 ULTRASONIC FLOW TRANSMITTER

1.	Type	:	Ultrasonic – Clamp On
2.	Accuracy	:	+/- 1 % of reading
3.	Repeatability	:	+/- 0.3 % of reading
4.	Rangeability	:	400 : 1
5.	Output Signal	:	4-20 mA DC with HART
6.	Measured Parameter	:	Volumetric flow, Totalized flow and flow Velocity
7.	Display	:	LCD with internal Key Pad (Flow rate & Totalization)
8.	Power Supply	:	24 V DC (2 Wire)
9.	Enclosure	:	SS (IP- 68 – Submersible)
10.	Mounting	:	SS Chain or Strap
11.	Accessories		1. Handheld calibrator 2. ½"NPT cable gland 3. Transducer cable 4. All mounting hardware (SS-316) 5. SS Nameplate
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Plant water service

Note: Multi-path insertion type (minimum 4 path) Ultrasonic Flow meter shall be provided for Raw water/ Cooling Water flow measurements.

transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

3.00.00 PROCESS ACTUATED SWITCHES

3.01.00 PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure
6.	Adjustments	:	a) Internal Set Point b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy ± 1.0% b) Accuracy of Setting Indication of ± 1.5%
13.	Ambient temperature	:	0 – 50 Deg.C

14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 2 Valve SS-316 barstock manifold f) ½" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's approval

3.02.00 DIFFERENTIAL PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure

6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom/ back connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy ± 1.0% b) Accuracy of Setting Indication of ±1.5%
13.	Ambient temperature	:	0 – 50 Deg.C
14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary Diaphragm seals for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 5 Valve SS-316 barstock manifold f) ½" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1.	Float material	:	SS-316
2.	Wetted parts	:	SS-316
3.	Float chamber	:	Stainless steel/Carbon steel, construction welded
4.	Float chamber mounting	:	Side mounted
5.	Fluid connection	:	Side – Side
6.	Fluid connection size	:	1" ANSI RF Flange (rubber line, if required)
7.	Drain	:	½ inch NPT with Plug
8.	Pressure rating of chamber	:	Minimum 1.5 times of design pressure
9.	Repeatability	:	+/- 1.5 mm or better
10.	Switch housing	:	Stainless Steel
11.	Switch housing type	:	IP- 65
12.	Type of switch	:	Snap acting magnetically operated hermetically sealed
13.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve c) ½"NPT cable gland

			d)	Stainless steel nameplate with alpha-numeric engraved for service and tag
	15. Application	:	During Detail Engineering on Owner's approval	

3.04.00 FLOW SWITCH

1.	Type	:	Paddle /Piston/Disk	
2.	Wetted part material	:	Stainless steel or Hastelloy for acidic application	
3.	End connection	:	a)	Threaded upto 1" line size with integral Tee
		:	b)	Flanged for line size > 1 ½"
4.	Enclosure material	:	Stainless Steel	
5.	Enclosure class	:	IP 65	
6.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)	
7.	Repeatibility	:	2%	
8.	Cable connection	:	½"NPTF	
9.	Accessories	:	a)	Tee, Counter flange, nuts & bolts, suitable gasket etc
			b)	½"NPT cable gland
			c)	Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

1.	Type	:	RADIO FREQUENCY
	Sensing probe		
2.	Material	:	SS-316
3.	Mounting	:	Threaded
4.	Application Temperature	:	250°C (Max.)
	Electronic Controller		
5.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6.	Relay Output	:	2 SPDT (240V AC, 5A)
7.	Ambient Temperature	:	50 °C
8.	Enclosure Protection	:	IP-66
9.	Enclosure Housing	:	SS
10.	Local LED Indication	:	Normal Level Power On Alarm Level Probe Healthy
11.	Switching Repeatability	:	±0.5%
12.	Accessories	:	Co-axial cable for probe connection to controller SS Tag plate ½" NPT Cable Glands
13.	Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1.	Type	:	Conductivity discrimination
2.	Probe MOC	:	SS-316
3.	Mounting	:	Flanged on external cage
4.	Application Temperature	:	250°C (Max.)
5.	Test Pressure	:	Two times rated pressure

	6. Input Supply Voltage	:	240V AC ±10%, 50 Hz.
	7. Input	:	Four independent channel with selectable switching threshold for water conductivity
	8. Relay Output	:	2 SPDT (240V AC, 5A)
	9. Ambient Temperature	:	50 °C
	10. Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
	11. Enclosure Housing	:	SS
	12. Local LED Indication	:	HI,LO, HIGH-HIGH, LOW-LOW Power Fault
	13. Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
	14. Application	:	During Detail Engineering on Owner's approval
3.07.00	TEMPERATURE SWITCH		
	1. Type	:	Bimetallic or gas filled
	2. Sensing Element Material	:	SS-316
	3. Bulb Material	:	SS-316
	4. Capillary	:	Stainless Steel armored

5.	Movement Material	:	Stainless Steel
6.	Case material	:	Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
7..	Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
8.	Over range Protection	:	120 %
9.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
11.	Switch type	:	Snap acting, shock and vibration-proof
12.	Adjustability	:	Internal Set point adjustable over span range
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length b) Case compensation
14.	Performance		
	a) Scale Accuracy	:	±1.0 % of full scale
	b) Repeatability	:	< 0.5 % of full range
	c) Response time	:	Less than 40 seconds with thermowell
15.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	Mounting accessories, ½" NPT cable gland
18.	Applications	:	During Detail Engineering on Owner's

approval

4.00.00 LOCAL INSTRUMENTS

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1.	Type	:	Bourdon/Bellows/Diaphragm
2.	Sensing & Socket	:	SS-316
3.	Movement Material	:	SS-316
4.	Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5.	Dial Size	:	Generally 150 mm
6.	Scale	:	Black lettering on white in 270 O arc.
7.	Window	:	Shatterproof glass
8.	Range Selection	:	Normal process pressure: 50~70 % of range
9.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	For Zero adjustment (Micrometer screw external) For Range adjustment (Micrometer screw internal).
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13.	Performance	:	Accuracy of ± 1.0 % of span or better
14.	Operating ambient	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc /diaphragm at the back
16.	Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals

			for corrosive/ viscous/ solid bearing or slurry type fluid applications
		c)	3-Way SS316 Gauge cock for pressure gauges
		d)	5-valve SS316 manifold from barstock for differential pressure gauge
		e)	Siphons for steam and hot water services
	17. Nameplate	:	Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1.	Type	:	Float and Board
2.	Float Material	:	SS-316
3.	Float Cable	:	SS-316
4.	Indicator Assembly	:	Epoxy painted Aluminium
5.	Guide wire spring assembly	:	SS-316 (2 Nos.)
6.	Guide Wire Anchor	:	SS-316
7.	Scale Board	:	Anodized Aluminium with engraved marking (Minimum graduation 10mm), mounting brackets and suitable hardware required as per tank height
8.	Elbow Assembly	:	Anodized Aluminium
9.	Flanges	:	RF , ANSI 150 , SS (3 Nos.)
10.	Accuracy	:	± 10 mm or better
11.	Accessories	:	All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material		
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
4.		:	ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks ii. Drain Valves iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate iv. Illuminating lamps, Mica shield as required v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ^{O} C
9.	Other details	:	For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

4.04.00 SLIGHT GLASS

1.	Type	:	Flap-type.
2.	End connection	:	Screwed / Flanged
3.	Material		
	a) Body	:	SS- 304
	b) Cover plate	:	SS- 304
	c) Indicator	:	SS- 316
4.	Sight Glass	:	Toughened Borosilicate
5.	Gasket	:	Neoprene
6.	Bolts & Nuts	:	High tensile steel.
7.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8.	Accessories	:	Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.

4.05.00 ROTAMETER

1.	Type	:	ON-LINE for line upto and including 50 mm NB. Borosilicate BY-PASS for line size above 50 NB
2.	Metering tube	:	Toughened Borosilicate
3.	Float	:	SS-316
4.	End fittings	:	SS-316
5.	Packing material	:	Teflon / PTFE
6.	Casing	:	Stainless Steel
7.	Gland Rings /Followers/ Other wetted parts	:	Stainless Steel
8.	Orifice Plate	:	Stainless Steel (for bypass type)
9.	Operating Temperature	:	0-50 Deg. c

10.	Test Pressure	:	200% of maximum operating pressure
11.	Scale	:	250 mm nominal length
12.	Graduation	:	Direct reading
13.	Process Connection	:	Flanged (RF) to line size as per ANSI standards (150#)
14.	Tapping	:	D & D/2
15.	Accuracy	:	+/- 2% of full scale reading
16.	Reproducibility	:	Within 0.5% of instantaneous reading
17.	Accessories	:	SS Tag Plate, orifice plate

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

1.	Type	:	Platinum (Duplex), Ungrounded
2.	Platinum (Duplex), Ungrounded	:	100 ohm at 0 ^{O}C
3.	Base	:	Wound on ceramic (anti-inductive)
4.	Wiring	:	3 Wire
5.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
6.	Response time	:	a) 15 sec. (bare).
			b) 30 sec. (with thermowell)
7.	Calibration	:	DIN 43760
8.	Accuracy	:	± 0.5%
9.	Head		
	a) Type	:	IP-65 universal screwed type

	b)	Material	:	Stainless Steel
	c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d)	Cable connection	:	½" NPT gland and grommet
	e)	Others	:	Terminal head cover with SS chain and suitable gasket. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
10.	Accessories		:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
11.	Thermowell connection		:	½" NPT (M) or 150 RF Flanged
12.	Nameplate		:	Tag number, service engraved in stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing 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 Pt-100.

5.02.00 THERMOCOUPLES

1. Type :
   a) 16 SWG wire of Chromel Alumel) (Type-K)
   b) Duplex
   c) Ungrounded
2. Protecting Tube
   a) O.D. : 6 mm
   b) Material : SS-316, Seamless
   c) Filling : Magnesium oxide (Purity above 99.4%).
3. Response time :
   a) < 20 seconds for measurement
   b) < 10 seconds for control
4. Accuracy : $\pm$ 1.1^0 C up to 300 ^{0} C & 0.4% of measured temperature range above 300 ^{0}C
5. Head
   a) Type : IP-65 universal screwed type
   b) Material : Stainless Steel
   c) Terminal blocks : Nickel plated Brass-screw type / silver plated
   d) Cable connection : ½" NPT gland and grommet
6. e) Others : Terminal head cover with SS chain and suitable gasket.

			Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	½" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

			cover conforming to IP 65.
	7. Dial size	:	150 mm
	8. Scale	:	Black lettering on white background in 270 Deg.C arc
	9. Over range protection	:	125 percent of FSD
	10. Capillary Glanding	:	1/2" NPT(M) x compression fitting (SS) to suit capillary
	11. Instrument Connection	:	Bottom connection for local mounting, back connection for panel mounting
	12. Process Connection	:	½" NPT (M) or 150 RF Flanged
	13. Extension Neck Length	:	50 mm
	14. Compensation	:	a) Capillary compensation
	15.	:	b) Case compensation
	16. Performance	:	a) Accuracy : + /- 1.0 percent of full scale Deflection
		:	b) Repeatability : Less than 0.5 percent of full range
		:	c) Response time: 15 seconds (max.).
	17. Capillary length	:	3.0 meters (local) / 15.0 metres (local panel)
	18. Other features	:	Shatter proof glass
	19. Nameplate	:	Tag number, service engraved in stainless steel tag plate
	20. Accessories	:	SS316 Thermowell

5.04.00 THERMOWELL

	1. Material	:	SS-316
	2. Manufacture	:	Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

1.	Type	:	Hydrometer Type
2.	Mounting	:	On line
3.	Accuracy	:	+/- 2% of range
4.	Scale	:	Black letter on white scale
5.	End connection	:	PVC flange

9.06.00 DENSITY/ CONCENTRATION METER

1.	Wetted Part		Stainless Steel
2.	Enclosure		Stainless Steel (IP-65)
3.	Power Supply		24 V DC
4.	Output signal	:	4-20 mA DC (isolated) into 600 ohms
5.	Accuracy		±0.001 g/cc
6.	Indication	:	LCD display
7.	Temp. Compensation	:	Integral
8.	Accessories		Mounting hardware, integral amplifier (if required), cable glands, tag plate etc.

10.00.00 **SOLENOID VALVES**

1.	Operating Principle	:	Electromagnetic (noiseless)
2.	Coil voltage rating	:	240 V AC /24 V DC (as required)
3.	Ways	:	2/3/4 way
4.	Port size	:	1/4" NPT all ports
5.	Body	:	SS bar stock
	Trim	:	SS-316
6.	Duty	:	Suitable for continuous energization
7.	Sealing	:	Airtight and leak proof
8.	Ambient Temperature	:	0 - 50 ^{O} C

9.	Fluid Temperature	:	0-150 ^{O} C (approx.)
10.	Coil Enclosure	:	Stainless Steel
11.	Insulation	:	Class-H
12.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
13.	Mounting	:	On pipe or on panel
14.	Cable Connection	:	½" NPT
15.	Accessories	:	Cable glands, SS Tag plate

Note : Solenoid valves shall be kept in pneumatic junction boxes only. Air distribution for SOV's shall be through SS manifold with SS isolation valves and auto drain traps and SS tubing from SOV to valves shall not be more than 6 meters.

PLC SPECIFICATION WITH CONFIGURATION DIAGRAM

PROGRAMMABLE LOGIC CONTROLER (PLC) / PROPRIETARY CONTROL SYSTEM

1.00.00 **GENERAL**

1.01.00 Each of the relevant BOP areas and different auxiliary systems shall be provided with dedicated PLC or proprietary control systems for overall operation and control.

1.01.01 The Common DDCMIS network shall also control and monitor the packages envisaged for PLC based local control systems. Operator workstations shall be provided in CCR for the overall control and monitoring of each system through network.

There shall be redundant bidirectional OPC link between this Common DDCMIS network and each Packge PLC including PADO for monitoring / performance activities.

These areas have been indicated with other details in Section-V of this volume of the specification.

1.02.00 These control systems shall conform to high standard of engineering meeting all applicable codes and standard, design and workmanship and shall meet the functional requirements in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental condition.

1.03.00 Further this part of the specification details the common technical and functional requirements applicable for all the systems unless specified elsewhere in the specification. Only specific requirements are indicated in this section .However ,Bidder shall also adhere to the Section-VI , Subsection A (DDCMIS) of this volume of the specification for other basic and detailed scope & services , philosophy & technical requirements of different hardwares and softwares including response time , loading , interface , redundancy criteria , display , logs ,spares criteria , drawings and document submission etc.

1.04.00 All local PLCs shall be supplied from one manufacturer for all plants and shall provide single unified hardware and software platform for realizing all the control and monitoring functions.

1.05.00 In general local PLC, ,Proprietary control system by third party system integrators shall not be allowed and only main PLC/ Proprietary control system manufacturer shall be allowed to do the design engineering , system integration etc. Owner will be the final authority in allowing third party system integrators , if required , for only small applications

1.06.00 Common DDCMIS shall basically control and monitor the BOP package systems , as detailed in section V of the volume of specification , through the workstations from the Central Control Room (CCR) during normal operation of the plant.. However, local control and monitoring facility of the equipments from the respective package control room and local panels shall also be available. However, if required, based on operator choice, normal and emergency operation from the local PLC system shall also be done. The control room operator shall have also access to common database for all the packages.

1.06.01 The redundant upper level network of each Package PLC system will be connected to redundant server to be located in Plant Engineer's room. Suitable Fibre optic cable shall be used for redundant interconnections.

1.06.02 The hot redundant Server shall continuously update all the inputs. The switchover to the hot standby Server shall be smooth and bump less with proper indication to the operator.

1.06.03 In addition to local PLC Workstations , programming activities for control systems of all the packages including set point change , logic build up & modifications , graphics build up & modifications etc . shall also be achieved through Common DDCMIS network workstation.

1.06.04 Common DDCMIS Network workstations stations, local workstations shall have access to the processor of the individual package control system for programming. Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

1.06.05 All the screens as available in the local package monitors will be also available one to one basis in the Common DDCMIS network screens. Alarm monitoring / reporting, generation of logs, trends, calculations, printing of logs & reports etc. shall be available in local workstations as well as in remote Common DDCMIS network workstations .In case of failure of Common DDCMIS network, control and monitoring of the individual packages shall still be possible from the Operator Work Stations in the respective package control room

1.06.06 There shall be flexibility in operation from CCR Common DDCMIS network operator workstations. Any of the BOP packages can be controlled and monitored from any of the workstations. .

1.06.07 The system shall permit carrying out of the on-line dynamic test and self-diagnostic checks while maintaining safe condition and without endangering the safety of equipment without having any influence on the process being controlled.

2.00.00 GENERAL TECHNICAL REQUIREMENTS

2.01.00 Bidders scope of supply shall include , but not limited to , Hot standby local PLC / Proprietary control & monitoring system for each of BOP areas and shall consist of IO cards, remote and Local IO rack, control rack, redundant Power supply modules, redundant communication /networking and interconnection Cables, redundant processor and communication cards, redundant Servers, operator work stations / GUI , LVS , printer, redundant networking hardware, redundant interface hardwares / softwares with DDCMIS , MCS , PADO etc. , system cabinets ,startup, commissioning, mandatory and recommended spares, drawing, documents and training to owner's personnels at site and at vendors works etc.

2.02.00 All types of programming packages shall be licensed with facility of editing and configuration. For each of the PLC / proprietary control system, the programming software shall be supplied in a laptop for each package

preloaded with package in addition to other types of devices such as CD, DAT etc.

2.03.00 In addition to the Operator and/ cum Engineering workstations , Bidder shall also supply LCD screen based display unit, control switches and other operational keys (GUI). Bidder shall also provide minimum of one no. laptop computer for each PLC based package and with latest hardware configuration and loaded with suitable operating , application program including licensed softwares as a backup engineering cum programming and configuration station. This loaded laptop shall be handed over by Bidder well in advance of FAT to Owner's head office at Hyderabad .

2.04.00 The System shall allow dependable and effective control of the process equipment and shall be designed for maximum integrity and reliability. Integrity shall be maintained by providing a dual hot redundant system .The System shall have a capability to monitor and take actions for distributed functions from a central location.

2.05.00 The control & Instrumentation shall be through dedicated microprocessor based PLC ,Common DDCMIS network ,proprietary system for the each of the respective plants covering the total functional requirement of sequence control, regulatory control, interlock & protection, monitoring, alarm, data logging.

2.06.00 The loop cycle time shall be less than 1 sec for close loops and open loops. The switchover from main controller to redundant controller shall be bumpless; and shall be within one cycle time i.e. within 50 msec.

2.07.00 Each controller shall have 40% functional capacity to implement additional functional blocks over and above implemented logic / loops under worst loading conditions.

2.08.00 Field Input/Outputs

The System shall meet the following I/O card requirements.
The maximum number of inputs / outputs to be connected to each type of module shall be as follows:

a)	Analog input module	8
b).	Analog output module	8
c)	Binary input module	16
d)	Binary output module	16

2.09.00 Communications System

2.09.01 The Bidder shall include a dual hot redundant communication system

2.09.02 The data highway speed shall be 1000 Mbps.

2.10.00 Operator Interface

Operator Work Station (OWS) / GUI / LVS shall perform control monitoring and operation of all auxiliaries/ drives . However , Push button stations are

also to be provided with RIOs as detailed out in Section V of this volume of the specification .

2.11.00 Interface with Common DDCMIS system

Each PLC , proprietary control systems shall be interfaced to Common DDCMIS network with bidirectional OPC link .The link shall be redundant.

2.12.00 PLC shall be of latest version and all the modules like Control modules, communication modules, IO modules, network interface modules etc., modules shall be from the same family of hardwares and softwares and shall be sourced from Bidder's Original Principlal's works.

2.13.00 PLC shall have also , but not limited to, the following requirements ,

2.13.01 I/O LAN Speed shall be minimum 5 Mbps - 100 MBPS on Deterministic LAN.

2.13.02 I/Os shall be Rack based and not Din Rail Mountable .

2.13.03 Processors and I/Os shall be of same family.

2.13.04 Channel Level Diagnostics for DI/DO, AI & AO shall be provided . Each individual Channel healthiness shall be monitored at workstation / GUI level.

2.13.05 All PLC I/O Rack Power Supplies shall be redundant. Only Bulk power supply redundancy will not be acceptable.

2.13.06 Processor shall have minimum 256 PID loops execution capability. Minimum memory shall be 10 MB. It should be 32 Bit.

2.13.07 SOE module (if applicable) must stamp and store 250+ events at card level.

2.13.08 PLC shall store tag details and bit word addresses on upload of logic as well as tag descriptions.

2.13.09 I/O Bit forcing in Primary to reflect in secondary immediately. (single scan update)

2.13.09 Remote I/O Rack outside control room shall be on Fiber Optic communication only.

2.13.10 Processor shall be self learning in case of failure. No need to configure and program replaced processor.

2.14.00 Operating work stations must be Runtime license/servers. Client server architecture no acceptable.

2.15.00 Each operator work station must have minimum 8000 tags handling capability.

2.16.00 Auto Tuning feature of PIDs at PLC controller level shall be available.

2.17.00 Floating IP selection of Controller under PLC processor switchover condition

2.18.00 Automatic Program update on secondary on loading to Primary Processor.

2.19.00 Programming facility shall be available from Remote IO stations.

2.20.00 Processor shall support minimum 22000 IO handling capacity in Redundant configuration.

2.21.00 Online editing of Program shall be possible.

2.22.00 Processors shall be Hot back up.

2.23.00 Automatic synchronization of primary processor/controller of PLC with secondary processor/controller.

2.24.00 Bumpless switchover to secondary processor/controller of PLC when the primary fails.

2.25.00 Power supply module redundancy shall be true power supply redundancy

2.26.00 Automatic program and data equalization of primary processor/controller of PLC.

2.27.00 Automatic 'Forcing Bit' update in the secondary processor/controller of PLC when any Forcing is applied in the primary processor/controller of PLC. (Forcing Bit Table of both the PLCs must be automatically synchronised.)

2.28.00 Communication speed of 5 Mbps between PLC and I/O module network

2.22.00 Softwares

The latest version of all necessary applications and networking software shall be supplied for the system. The software tool shall have facility to interface with third party software packages. Window base operating system shall be provided. The system shall be OPC compliant. Easy upgradation and future expansion facility shall be available.

All softwares used shall be licensed versions only. All software user licenses shall be valid for entire life of power plant. User shall not have to pay any recurring license fee during the usage period of the system.

It shall be possible to upgrade the installed system with the latest available version of the software model during the plant life.

2.23.00 Redundant Uninterrupted Power Supplies (UPS) shall be provided for each Local PLC.. UPS specification shall be as per requirements indicated in Section V of this specification.

	TITLE:	SPECIFICATION NO. PES-145-36	
BHEL	**SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM**	VOLUME **II-B**	
		SECTION **D**	
		REV. NO. 02	DATE: July 19, 2008
		SHEET **1**	OF 9

1. SCOPE

This specification covers the Design, Manufacture, Assembly, Inspection and Testing at manufacturer's works, proper packing and delivery to site, erection and commissioning of the PLC Control & Monitoring System comprising PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Operator workstations(OWS), Printers, Annunciation system, UPS, cables and all other equipments and accessories required for completeness of the system as mentioned in different sections of this specification.

2. GENERAL

2.1. The PLC shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, input quality checking engineering unit conversion, Boolean functions & PID control (Analog logic function).

2.2. The system shall be redundant in processor, power supply and communication interfaces unless otherwise specified. The system shall have self-diagnostic features. The control of all drives and equipment shall be effected through the keyboard/mouse / panel mounted push button / control switches as per Data sheets-A&B.

2.3. The system shall have facility for connecting to Main Plant's Distributed control system (DCS) using hardware / software interface for two-way transfer of signals.

2.4. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Data sheets).

2.5. In case OWS is provided, HMI functions like Trends, Curves, Bar charts, Historical storage of Data, Logs and reports etc. shall be provided in addition to Plant-schematics. The necessary catalogue / literature elaborating the features of HMI shall be supplied along with the bid.

2.6. It shall be possible to use the same OWS as programming station.

2.7. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.

2.8. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.

2.9. Signal multiplication where required shall be done in PLC. Use of relays for multiplication of contacts (for control, monitoring and alarm) is not acceptable. The control/ monitoring components on the control panel/ desk shall be driven through I/O modules.

3. TECHNICAL REQUIREMENTS

Details of various PLC system components shall be inclusive of but not limited to the following:

3.1. CODES AND STANDARDS

3.1.1. The equipment covered under this specification shall meet the requirements of latest edition of all applicable codes and standards like ANSI, NEMA, IEEE, IEC, NEC

3.1.2. PLC shall conform to IEC: 1131

3.1.3. The offered PLC shall comply with safety standards as per Data sheet-A&B.

3.2. CONTROL PANEL

3.2.1. PLC control panel shall be freestanding type with provision for mimic display, push-button stations, control switches, indicating lamps, metering instruments like Indicators, ammeters etc. and facia windows for critical alarms.

3.2.2. The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.0 mm for load bearing sections (mounted with instruments) and Not less than 1.6 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.2.3. Each panel shall be identified by a name plate, which shall be of non-rusting metal or three ply lamicold, with engraved lettering.

3.2.4. 25 x 6 mm Copper ground bus to be provided for each panel.

3.2.5. 240V AC single phase, thermostatically controlled space heaters shall be provided. Each free standing panel shall have a door switch operated fluorescent lamp and a 240V AC plug point.

3.2.6. Painting treatment shall be as per IS: 6005. Two coats of lead oxide primer shall be followed by powder coating. Paint shade shall be as specified in the “Data sheet for PLC system”-Data Sheet-A&B.

3.2.7. The annunciation system shall be facia window type, driven by the PLC. Audible alarm, Acknowledge, Reset and lamp test facility shall be provided as per ISA sequence – S18.1, M.

3.8. COMMUNICATION WITH PLANT DCS

3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS.

3.8.2. Serial communication to / from DCS where provided shall be engineered to ensure that signal communication time from / to DCS shall not exceed 1 seconds for control / feedback.

3.8.3. Serial communication to DCS shall be OPC (Data access 2.0), Ethernet based TCP/IP Protocol. Alternatively the serial communication shall be MODBUS protocol on RS 485 network.

3.8.4. Data transmitted from PLC to DCS shall include all information necessary for the DCS graphic displays to monitor and control the process equipment and PLC. Such data may include pertinent analog and digital status information, interlock, alarms and maintenance conditions. Data transmitted from DCS to the PLC shall include necessary signals to provide operator control interface from DCS for the process/ equipment being controlled by PLC.

3.8.5. Bidder to include 'Light interface units, converters, Ethernet switch, accessories at PLC end for connectivity to other system. The bidder's terminal point shall be Ethernet port in case of copper medium connection to DCS or LIU in case of Fiber optic medium for connectivity with plant DCS. In case distance between PLC & DCS is greater than 1.8 Km, single mode of optical fiber cable with compatible accessories shall be used. For distance less than 1.8 Km multimode optical fiber ports shall be used.

3.9. POWER SUPPLY Scheme

3.9.1. PLC Panel and I/O Cabinets: PLC system shall be provided with 2x100% UPS fed from Two Nos. redundant 415V, 3-ph feeders, ~~as per the scheme PE-SD-999-145-001, sh-08 of 08. Each UPS shall have 30 minutes back up.~~ Input feeder failure shall be monitored in the PLC system. Necessary redundant power pack and transformers shall be provided (in the PLC panel) to derive the power supply for control desk, PLC panel and input / output cabinets etc

3.9.2. Remote I/O panels: Similar power supply arrangement as for PLC panels shall be provided if it is not possible to extend the power cable form UPS of PLC panels.

3.9.3. Each OWS and associated HMI peripherals shall be provided with a feeder from either one of the UPS

4. DRAWING/DOCUMENT AND DATA TO BE FURNISHED AFTER AWARD OF THE CONTRACT:

4.1. For Approval:

- PLC system configuration drawing along with functional write-up.
- Input/Output signal list.
- BOM of PLC
- List of PLC controlled devices
- Control panel/control desk GA drawings.
- Control desk/panel component layout drawing.
- Control panel/control desk Foundation detail and cutout drawings
- Power distribution scheme.

- Block logic diagrams.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares
- Quality plan
- Data Sheet-C
- CRT display
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

4.2. For Information:

- Cable schedule and cable interconnection drawing(in BHEL approved format)
  - Between Field and PLC
  - Between Field and MCC
  - Between MCC and PLC
- Electronic earthing requirements.
- Panel Heat dissipation data
- Product/component catalogues.
- Operation & Maintenance Manual on CDs.
- Softcopy of Final/As-built drawings on CDs.
- Calculation for Processor, Memory & Data bus loading

The above list is the minimum requirements. Additional documents/calculations required shall be finalized during contract stage.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

- Proposed PLC system configuration drawing with write-up
- Product catalogues and specifications for PLC as well as HMI application.
- Proposed power supply schemes for PLC system, peripherals, and Remote I/O panels.

6. TESTING AND INSPECTION

6.1. The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

6.2. BHEL's standard Quality Plan for PLC is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

6.3. The complete PLC system, including all instrument and devices shall be subjected to standard factory tests (i.e. Type Tests and Routine Tests) as per relevant NEMA, IEEE, IEC.

6.4. Factory Acceptance Test-FAT (Functional Tests) shall be performed prior to shipment and Owner/Purchaser shall be notified 15 days before the schedules dates of the test.

6.5. The certificates for following type tests, as per IEC Standard, shall be submitted: -

- Surge protection test as per IEC-225-4
- Dry heat test as per IEC-68-2-2
- Damp Heat test as per IEC-68-2-3

- Vibration Heat test as per IEC-68-2-6
- Electrostatic discharge test as per IEC-801-2 or equivalent
- Radio frequency Immunity test as per IEC-801-6 or equivalent
- Electromagnetic Immunity test as per IEC-801-3 or equivalent

7. SPARES AND CONSUMABLES

7.1. Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

7.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

7.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

7.4. Special Tools & Tackles

The bidder shall supply all Special Tools & Tackles 'as required' during Start-up and further maintenance of the system, as part of the main equipment supply.

7.5. Spares, Service support

Bidder shall provide availability of spares and service support for minimum 10 years after guarantee period.

8. MARKING AND PACKING

8.1. Marking:

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag/serial Number and salient technical specification.

8.2. Packing:

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transit and storage in open.

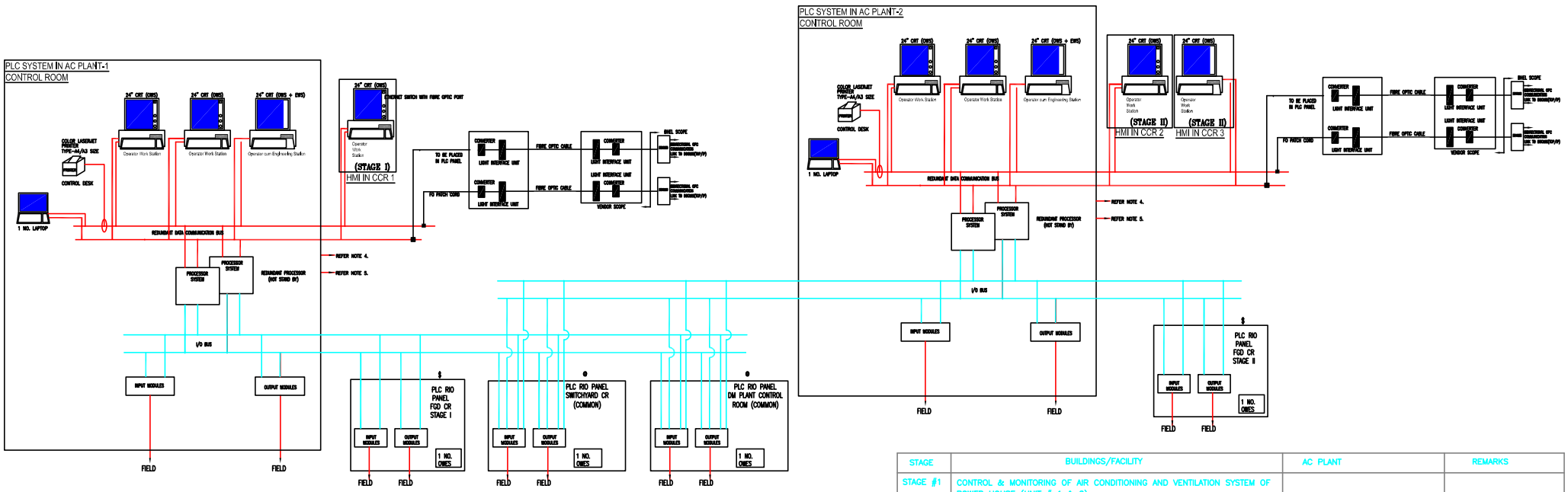
9. PERFORMANCE AND GUARANTEE

The PLC system shall be guaranteed to meet the performance requirement as specified and also for trouble-free continuous operation for 12 months from the date of commissioning or 18 months from the date of delivery at site whichever is later unless specified otherwise in Vol-IIB Section - B or Section - C.

MICROPROCESSOR BASED CONTROL SYSTEM

Microprocessor based Control Panel with GIU for Control and Operation of Air Conditioning System for Admin Building shall be provided. The Microprocessor based Control System shall be capable of executing the following functions: -

1) Receiving binary and analog signals from the field and providing ON-Off command for Machine Operation.
2) Implementing all logic functions for control, protection and annunciation of the equipment and systems.
3) Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
4) Performing self-monitoring and diagnostic functions.



NOTES:

1) TABLE TOP OWS/EWS SHALL BE 24"
2) ALL PLCS SHALL HAVE DUAL HOT REDUNDANT PROCESSOR AND EACH RACK SHALL HAVE DUAL POWER SUPPLY MODULES, DUAL NETWORK COMMUNICATION CARDS/MODULE FOR DUAL REDUNDANT RING OR DUAL REDUNDANT STAR NETWORK.
3) REDUNDANT UPS POWER SUPPLY SHALL BE USED FOR PLC PANEL(S),RIO, BACKUP PANELS, OWS/EWS,4 WIRE INSTRUMENTS AND NETWORK COMPONENTS.FOR APPLICABLE UPS SCHEME REFER DWG:PE-DG-417-145-I004
4) SWITCHYARD PLC RIO, DM PLANT PLC RIO SHALL BE FED FROM BOTH STAGE#1 & STAGE#2 UPS's.
5) PLC PANEL SHALL HAVE PROVISION TO ACCEPT TIME SYNC. SIGNAL (NTP/IRIG-B) FROM MASTER CLOCK SYSTEM.
6) PLC PANEL SHALL HAVE PROVISION FOR DATA EXCHANGE (OPC) WITH PLANT DCS. NECESSARY OPC CLIENT/SERVER SOFTWARE TO BE PROVIDED.SEPERATE OPC SERVER FOR EACH PLC SHALL BE PROVIDED.
7) NECESSARY PATCH CORD/CONVERTERS, LIU AT BOTH PLC AND DCS END SHALL BE IN BIDDER SCOPE FOR OPC LINK TO DDCMIS.
8) PLC SPECIFICATION SHALL BE AS PER KTPS TENDER SPECIFICATION VOLUME-VI, SECTION VI, SUBSECTION B ONLY
9) PLC PROCESSOR AND IO CARDS/MODULES SHALL BE FROM SAME FAMILY AND SHALL BE OF LATEST MODEL.
10) NOT USED.
11) FIELD INSTRUMENT REDUNDANCY SHALL BE AS PER SPECIFICATION ONLY. PROTECTION & CLCS: TRIPLE REDUNDANCY; INTERLOCK/ PERMISSIVE:DUAL REDUNDANCY; MONITORING/ ALARM: SINGLE
12) ALL RTDS/ THERMO COUPLES IF APPLICABLE SHALL BE DUPLEX TYPE NECESSARY PATCH CORD, CONVERTERS, LIU ETC AT BOTH PLC AND DCS END SHALL BE IN VENDORS SCOPE.
13) VENDOR TO PROVIDE HIRSCHMAN MAKE ETHERNET SWITCHES ONLY
14) REDUNDANT UNINTERRUPTED POWER SUPPLIES (UPS IN BHEL SCOPE) SHALL BE PROVIDED FOR THE STAGE WISE PLC SYSTEM, RIO PANELS, HMI AT EACH LOCATION BASED ON THE LOAD DATA PROVIDED BY THE BIDDER. REDUNDANT NON-UPS SUPPLY FEEDER 415 V, 3 PHASE, AC SUPPLY SHALL BE PROVIDED BY BHEL BASED ON THE LOAD DATA PROVIDED BY THE BIDDER. NECESSARY REDUNDANT ACDB'S SHALL BE CONSIDERED AND PROVIDED BY BIDDER AT EACH LOCATION.

* - STAGE WISE i.e. STAGE I & STAGE II PLC PANEL IS ENVISAGED IN AC PLANT-1 AND AC PLANT-2 RESPECTIVELY.

$ - STAGE WISE i.e. STAGE I & STAGE II PLC RIO PANEL IS ENVISAGED IN FGD ROOM-1 AND FGD ROOM-2 RESPECTIVELY.

@ - COMMON PLC RIO PANEL IS ENVISAGED IN SWITCHYARD ROOM AND DM PLANT CONTROL ROOM WHICH WILL BE HOOKED UP WITH BOTH STAGE I AND STAGE II PLC PANELS.

STAGE	BUILDINGS/FACILITY	AC PLANT	REMARKS
STAGE #1	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF POWER HOUSE (UNIT # 1 & 2)	PLC IN AC PLANT-1 LOC: GROUND FLOOR OF POWERHOUSE-1&2	
STAGE #1	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF ESP BUILDINGS (UNIT # 1 & 2)		
STAGE #1	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF FGD CONTROL ROOM (STAGE # 1)		RIO SHALL BE PROVIDED LOC: FGD MCC & CONTROL BLDG.#1
STAGE #1	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF SERVICE BUILDING (STAGE # 1)		
COMMON	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF DM PLANT CONTROL ROOM		RIO SHALL BE PROVIDED LOC: DM PLANT CONTROL ROOM
STAGE #1	CONTROL & MONITORING OF V. SOFTENING PLANTS PROVIDED FOR AC PLANTS LOCATED IN ABOVE AREAS		
COMMON	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF SWITCHYARD CONTROL ROOM		RIO SHALL BE PROVIDED LOC: SWITCH YARD CONTROL ROOM
STAGE#2	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF POWER HOUSE (UNIT # 3, 4 & 5)	PLC IN AC PLANT-2 LOC: GROUND FLOOR OF POWERHOUSE-3&4	
STAGE #2	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF ESP BUILDINGS (UNIT # 3, 4 & 5)		
STAGE #2	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF FGD CONTROL ROOM (STAGE # 2)		RIO SHALL BE PROVIDED LOC: FGD MCC & CONTROL BLDG.#2
STAGE #2	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF SERVICE BUILDING (STAGE # 2)		
COMMON	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF DM PLANT CONTROL ROOM		RIO SHALL BE PROVIDED LOC: DM PLANT CONTROL ROOM
STAGE #2	CONTROL & MONITORING OF V. SOFTENING PLANTS PROVIDED FOR AC PLANTS LOCATED IN ABOVE AREAS		
COMMON	CONTROL & MONITORING OF AIR CONDITIONING AND VENTILATION SYSTEM OF SWITCHYARD CONTROL ROOM		RIO SHALL BE PROVIDED LOC: SWITCH YARD CONTROL ROOM

LEGEND: –

PLC	– PROGRAMMABLE LOGIC CONTROLLER	LCR	– LOCAL CONTROL ROOM
DCS	– DISTRIBUTED CONTROL SYSTEM	CCR	– COMMON CONTROL ROOM
UPS	– UNINTERRUPTED POWER SUPPLY	OPC	– OLE PROCESS CONTROL
OWS/OEWS	– OPERATOR WORK STATION/ ENGINEERING WORK STATION		
HMI	– HUMAN MACHINE INTERFACE	MCCB	– MOULDED CASE CIRCUIT BREAKER
NTP	– NETWORK TIME PROTOCOL	MCB	– MINIATURE CIRCUIT BREAKER

BHARAT HEAVY ELECTRICALS LIMITED	PROJECT: 5 X 800 MW YADADRI TPS	DRG.NO.	PE-DM-417-145-I900
		DATE	19.06.2020
	TITLE: PLC CONFIGURATION AC/VENTILATION	REV.NO.	03
		SHT	5 OF 8

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STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-I036___**
VOLUME IIB
SECTION D
REV. NO. 01 DATE: 24.08.2007
SHEET 1 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.0	**Materials /Components**											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visua l	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2 2		1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visua l	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2 2		1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visua l	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2 2		1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA	Visua l	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2 2		1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.
1 - BHEL 2 - Vendor 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-I036___**
VOLUME IIB
SECTION D
REV. NO. 01 DATE: 24.08.2007
SHEET 2 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2 2		1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
2.0	**Assembly**											
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2 1		1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2 2		1	
2.3 Po	wering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2 1		1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100% F	AT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2 2		1	

LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
3.0	**Factory Acceptance Test (FAT)**											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.
1 - BHEL 2 - Vendor 3 - Sub-vendor

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

a) Technical Specification of PLC.

b) PLC System Configuration

c) General Assembly Drawings.

d) Panel Wiring Diagrams.

e) Bill of Quantity for PLC System.

f) Logic Diagram.

g) HMI Schematics.

h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, to the inspecting agency, his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. Check online replacement of cards, processors, power supply etc.

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

i) Redundancy

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.
Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

6. Control Panel /Desk Verification

i) PLC driven annunc iation system should be checked by alar m signal simulation.

ii) Push Button and sele ctor switch operation should be checked by verification of corresponding change of status of Data Base point.

iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes

ii). Engineering features:-
a) Online changing of parameters, set points.
b) Online modification in Control Logic Diagrams.
c) Online configuration of Graphics, Trends, Logs, HSR.

iii). HMI features:-
Check for configuration & ope ration of Graphics, Trends, Logs, HSR and Alarms, in the for m of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipment s shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

ii) 48 hours test period shall be divided into 4 equal time segment of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.

b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.

UPS is in BHEL scope. However, ACDB's (redundant) at each location are in bidder's scope of supply.

NOTES:

1. ACDB–1&2 NEUTRAL TO BE GROUNDED TO A DEDICATED GROUND.
2. ALL OUTPUT FEEDERS OF ACDB SHALL BE PROVIDED WITH AN LED AFTER THE FUSE FOR FEEDER ON INDICATION WITH FEEDER DESCRIPTION.
3. REDUNDANT FEEDERS SHALL BE LOCATED IN DIFFERENT ACDBs.
4. Not used.

5. THE FOLLOWING LIST OF ESSENTIAL SIGNAL EXCHANGE BETWEEN UPS TO DCS OR PLC SHALL BE BOTH HARD WIRED (4–20MA) AND THROUGH THE SOFT SIGNALS (RS–485).
   A. UPS MAIN INPUT VOLTAGE AND CURRENT
   B. CHARGER OUTPUT VOLTAGE
   C. BATTERY CHARGING AND DISCHARGING CURRENT
   D. INVERTER OUTPUT VOLTAGE AND CURRENT
   E. ACDB OUTPUT VOLTAGE AND CURRENT
   F. INVERTER OUTPUT POWER FACTOR
   G. SCVS O/P VOLTAGE, CURRENT.
   H. AFTER LINE TRANSFORMER–1&2 VOLTAGES.
   I. DC VOLTAGE, & CURRENT
   J. STATIC SWITCH MAIN I/P , ALTERNATE I/P VOLTAGE
   K. UPS–1&2 –KVA,KW O/PS.
   L. UPS–1&2 POWER FACTOR, SYSTEM& GRID FREQUENCY.
   M. EMERGENCY AC SUPPLY VOLTAGE & CURRENT.

ALL THE UPS INPUTS/OUTPUTS SIGNALS SHALL BE INDICATED IN I/O LISTR

ERECTION HARDWARES

1.00.00 GENERAL TECHNICAL REQUIREMENTS

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

However, any item required for erection of Bidder supplied system but not categorically indicated in this section, shall be supplied by the Bidder and all these items shall conform to International / National standards / codes.

1.01.00 Electrical Accessories

Electrical conduit and associated materials shall conform to the requirements of the articles which follow :

a) Rigid Steel Conduit

i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.

ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.

iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with IS:9537 Part-I (1980) and Part-II(1981).. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel lacker or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.

iv) All rigid conduit fittings shall conform to requirements of IS:2667,1976. Galvanised steel fittins shall be used wth steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fitting shall be compatiable with the flexible conduit supplied.

b) Flexible Conduit

i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.

ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.

c) Special Fittings

i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.

ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

1.02.00 Electrical Junction Box:

Please refer to Section VII , Subsection – D of this volume of the Specification.

1.03.00 Cable Gland

1.	Type	: Double compression
2.	Entry Thread	: NPT / ET
3.	Material	: Brass
4.	Finish	: Cadmium Plated.
5.	Protection	: IP 54 or better
6.	Accessories	: Neoprene gasket, locknuts, reducers etc

1.04.00 Cable Tray

1.	Material	: Mild steel, slotted
2.	Thickness	: not less than 2.0 mm
3.	Finish	: Hot dip galvanized
4.	Perforation	: As per MFR standard
5.	Cover	: Suitable for tray

1.05.00 Process Hook Up Accessories & specification

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.

1.05.01 Seamless Stainless Steel Pipe

1.	Reference	: ASTM A-312 TP 316
2.	Material Grade	: TP 316
3.	Type	: Seamless /Plain end
4.	Size	: As applicable (e.g.½" NB etc)
5.	Schedule	: 40
6.	Standard Length	: 5 meter

1.05.02 Stainless Steel Pipe Fittings

	1.	Reference	: ASTM A-182 F 316 / ANSI B16.11
	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: To suit related SS pipe.
	5.	End connection	: Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.03 Seamless Stainless Steel Tube

	1.	Reference	: ASTM A-213 , ASTM A-249 or ASTM A-269
	2.	Material Grade	: TP 316
	3.	Size	: As applicable (e.g.½" OD X 0.083" wall thickness / ¼" OD X 0.049" wall thickness etc.)
	4.	Type	: Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
	5.	Properties	: The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
	6.	Test Pressure	: 400 Kg/Sq. cm (minimum)
	7.	Tolerance	: ± 0.13 mm for outside diameter
			: ± 15 % for wall thickness
	8.	Standard Length	: 5 meter
	9.	Test	: Flare, Hardness, Ball and Bubble Test

1.05.04 Stainless Steel Tube Fittings

	1.	Reference	: ASTM-A-182
	2.	Type	: Double ferrule double compression
	3.	Material	: 316 Stainless steel forged
	4.	Ferrule	: 316 Stainless Steel

	5.	Type of Fittings	: Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
	6.	Size	: To suit SS tubing and NPT end connection

1.05.05 C.S. Pipe

	1.	Reference	: ASTM-A 106 Gr. C
	2.	Material	: Cold drawn seamless black C.S.
	3.	Type	: Seamless / Plain ends
	4.	Size	: As applicable (e.g. ½" NB etc)
	5.	Schedule	: 80, 160, XXS as required
	6.	Standard Length	: 5 meter

1.05.06 C.S. Pipe Fittings

	1.	Reference	: ASTM-A 105 / ANSI B16.11
	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: Suitable to related C.S.Pipe
	5.	End connection	: Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.07 A.S. Pipe

	1.	Reference	: ASTM-A 335 P22 AS PER ANSI B 36.10
	2.	Material	: Cold drawn seamless A.S.
	3.	Type	: Seamless / Plain ends
	4.	Size	: As applicable (e.g. ½" NB etc)
	5.	Schedule	: XXS
	6.	Standard Length	: 5 meter

1.05.08 A.S. Pipe Fittings

1.	Reference	: ASTM-A 182 F22 AS PER ANSI B 16.11	
2.	Type	: Forged	
3.	Rating	: 9000 lbs	
4.	Size	: Suitable to related A.S.Pipe	
5.	End connection	: Generally socket weld	
6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.	

1.05.09 G.I.Pipe

1.	Reference	:	IS-1239, Part-I
2.	Type	:	Medium grade, threaded at both ends protected with end caps
3.	Material	:	Continuous ERW galvanized MS pipe
4.	General	:	Pipe shall be galvanized both inside and outside
5.	Size	:	As applicable (e.g 1/2"/3/4"/1" etc.)

1.05.10 G.I.Pipe Fittings

1.	Reference	:	IS-1239, Part-II for material, dimension, thread etc.
2.	Style	:	Threaded
3.	Type of Fittings	:	Equal tee, three piece union, unequal tee, straight socket, 90 Deg. elbow, reducing socket cap. etc. to suit installation.
4.	Size	:	Suitable to related G.I.Pipe

1.05.11 Carbon Steel Globe Valve

1.	Reference	: ASTM A-105
2.	Type	: Globe
3.	Construction	: Forged Body Cadmium Plated
4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
5.	Rating	: Cl. 800 / CL. 2500

	6.	Material	: Body - Carbon steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon / Grafoil as required
	8.	Yoke	: ASTM A105
	9.	Hand wheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

1.05.12 Stainless Steel Globe Valve

	1.	Reference	: ASTM A-182 F316
	2.	Type	: Globe
	3.	Construction	: Forged Body
	4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
	5.	Proof Pressure	: 400 Kg/Cm2
	6.	Material	: Body - Stainless steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon as required
	8.	Yoke	: ASTM A182 F316
	9.	Handwheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

1.05.13 Alloy Steel Globe Valve

	1.	Reference	: ASTM A-182 F22
	2.	Type	: Globe
	3.	Construction	: Forged Body

4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
5.	Rating	: CL. 2500
6.	Material	: Body - Alloy steel
		: Stem - Hardened Steel
		: Plug - AISI 316 SS
		: Seat- Stainless steel stellited
7.	Packing	: Grafoil as required
8.	Yoke	: ASTM A182 F22
9.	Handwheel	: Carbon steel
10.	Design standard	: As per ANSI B 16.34

1.05.14 Structural Steel

Steel supports for JB's, trays; tubes and related equipments shall not be limited to the following:

a) MS Angle
b) MS Channel
c) I-Beam
d) Hexagonal head Bolt & Nut with washer
e) Foundation Bolt & Nut
f) Expansion Bolt
g) Steel Plates / Flats
h) CRCA sheet
i) 50 NB Pipe
j) Pipe clamps, U Bolts & Nuts
k) Checker plate

1.05.15 Condensate Pot

1.	Reference	: ASTM A182 F22 /ASTM A105
2.	Material	: Alloy steel / carbon steel as per application
3.	Construction	: Drilled from barstock
4.	End connection	: As applicable (e.g 3 nos. ½" socket weld end etc.)

	5.	Accessories	: Vent valves
1.05.16	Instrument Valve Manifold		
	1.	Type	: Two valve manifold
			: Five valve manifold
	2.	Mounting	: Remote 2" Pipe Mounting / Transmitter Rack mounting
	3.	Construction	: Single block (bar stock)
	4.	Material	: Forged body and bonnet AISI 316 stainless steel
	5.	Ports	: Mfg std. (e.g 1/2 " NPT (F) etc.)
	6.	Rating	: 420 Kg/Sq. cm at ambient
	7.	Operating Temperature	: (-)30 to (+)170 Deg C
	8.	Packing	: PTFE Wafer
	9.	Seat & Stem	: AISI 316 SS
	10.	Plug	: AISI 316 SS free to turn on stem / 17-4 PH
	11.	Handle Bar	: AISI 316 SS
	12.	Connection	: Straight
	13.	Accessories	: Plugs for all ports, Mounting Bracket , bolts , nuts

1.06.00 Pneumatic Hook Up Accessories

1.07.00 Air Header

Technical Particulars	**For Panel**	**For Field**
Material of Construction	: Stainless steel	: Stainless steel
Inlet Connection	: 2" NPT (M)	: 1" NPT (M)
Header Take-off Material	: Stainless steel	: Stainless steel
Take off connection	: 1 / 2" NPT (M)	: 1/ 2" NPT (M)
Take-off Valves Material	: stainless steel	: stainless steel

Tube Take-off	: Tube adapter on valve	: Tube adapter on valve
Drain	: SS drain valve at lowest point	: SS drain valves at lowest point

KKS PHILOSOPHY

DOCUMENT TITLE

KKS NUMBERING 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) Compressed air system : QEA, QEC
2) Ventilation System : SAA TO SAZ
3) Fire Detection & Protection System + Fire Water pumps : SGM, SGN, SGO, SGP
4) Sewage Treatment : SJA TO SJZ
5) Pre-treatment Plant : GBI, GBM, GBV
6) RO DM Plant : GCI, GCM, GBV

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.

LCP and JUNCTION BOXES SPECIFICATION

1.00.00 **GENERAL REQUIREMENT**

1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT

1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.

1.02.00 SURFACE PREPARATION & PAINTING

1.02.01 All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.

1.02.02 Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:

- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
- Interior - Brilliant White.

1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

1.03.00 WIRING

1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.

1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.

1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.

1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices

1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.

1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.

1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.

1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.

1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.

1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

1.04.00 TERMINAL BLOCKS

1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.

1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.

1.04.03 The characteristics of the terminal blocks shall be as follows.

i) High contact force, independent of conductor cross-section and large contact surface area.

ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.

iii) Inspection and maintenance free (resistant to thermal aging and vibration)

iv) Low and constant voltage drop

1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.

1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.

1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.

1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.

1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

1.04.11 Other requirements of the terminal blocks are as follows:

i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

1.05.00 GROUNDING

1.05.01 Separate Protective and Electronic system ground as required shall be provided.

1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.

1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground .The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open .The electronic ground between panels of a shipping section shall be firmly looped.

2.00.00 **CONTROL DESKS & PANELS**

2.01.00 GENERAL

2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

accessories as required for completeness of the system.

2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.

2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.

2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.

2.01.05 For Control desk/ panel 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 wih suitably rated MCB and provision of fast auto changeover of UPS feeders.

2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

2.01.07 Nameplate

a) Nameplate shall be provided for instrument or device mounted on the panel.

b) Nameplates for panels shall be provided both in front and rear.

2.02.00 CONTROL DESK

2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.

2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.

2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.

2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

2.02.05 Design shall include Earthing bolts.

2.02.06 Back installed items shall be suitably concealed from front view.

2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.

2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)

Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.

2.03.00 BACK UP PANEL

2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.

2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.

2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:	Cold Rolled Coal Annealed (CRCA) steel sheet	
2.	Thickness of Sheet	:	a)	2.0 mm for faces supporting instruments / terminals
		:	b)	1.6 mm for other sides and top
3.	Construction	:	Welded throughout as per approved National Standards	
4.	Post welding operation	:	a)	Grounding of all welds to smoothness
		:	b)	Rounding of corners

		:	c)	Cleaning of weld spatters
5.	Panel height	:	2300 mm (approx)	
6.	Corners	:	7 mm inner radius	
7.	Dimensional Tolerances	:	a)	In height & length - 3 mm
			b)	In height between adjacent sections - 2 mm
			c)	Total for a group - 6 mm
8.	Doors	:	Double, recessed, turned back edges, full height front & rear	
	i) Thickness of Sheet	:	2 mm	
	ii) Hinges	:	Stainless steel	
	iii) Door latches	:	Three point type	
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure	
	v) Opening of the doors	:	Outward	
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof	
9.	Gland plates	:	Removable in sections 4 mm thick (bottom)	
10.	Cable entry	:	Bottom	
11.	Hardware	:	a)	Anti vibration pad- 15 mm
			b)	Predrilled base channel ISMC – 100 or equivalent for all sides
			c)	Stainless steel buff- finished 2 mm thick kick plate for all sides
			d)	Stainless steel scratch strips along desk edges fixed with pan-head recessed screws
			e)	Rubber strips to ensure air

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixures

12.	Name Plate	:	Both at front and back surface of the panel
13.	Fixing of name plate	:	Stainless steel pan head screws
14.	Name plate material	:	Laminated phenolic (3 layers)
15.	Lettering	:	Black with white engraved
16.	Mounting of terminal blocks	:	Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

2.05.03 CHAIRS

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHS

Steel Almirahs shall be provided for keeping documents in the documentation room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed Engineering.

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

4.00.00 **LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)**

4.01.00 GENERAL

4.01.01 Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Boiler/TG Building and Off-site plant areas.

4.01.02 Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.

4.01.03 No more than six instruments shall be grouped in a single rack / enclosure.

4.01.04 Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.

4.01.05 Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.

4.01.06 Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging

4.01.07 Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

4.01.08 Earth stud shall be furnished at rack for safety grounding.

4.02.00 LOCAL INSTRUMENT ENCLOSURE (LIE)

4.02.01 Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.

4.02.02 Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.

4.02.03 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any

member, which would reduce access, shall be avoided.

4.02.04 Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.

4.02.05 Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.

4.02.06 Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.

4.02.07 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.

4.02.08 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

4.02.09 Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and 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.

4.02.10 Power supplies for miscellaneous devices shall be provided with 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.

4.02.11 Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations

4.03.00 LOCAL INSTRUMENT RACK (LIR)

4.03.01 Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with 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.

4.04.00 JUNCTION BOX

1.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2.	Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3.	Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4.	Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

			Surface / Two (2) inch Pipe stanchion
5.	Mounting	:	(At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
7.	Gasket	:	Neoprene
8.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	:	Two at bottom capped
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.

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	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A	
		VOLUME	
		SECTION	
		REV. NO. 02	DATE: 16.09.2013
		SHEET 1 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		■ FOLDED ☐ WELDED	
	ENCLOSURE SHEET THICKNESS **(As per Section 8.13,Volume V of contract specification)**	FRONT	☐2.0 mm	
		OTHER	☐ 2.0 mm	
		DOOR	☐ 1.6 mm	
		HEIGHT	☐ 2365 mm for stand alone panels. ☐ Other	
		OTHER	☐ Load bearing sheet front shall have 3mm thickness	
TECHNICAL	INPUT POWER SUPPLY * **(As per Electrical specification)** (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		☐ 240V 50 Hz AC ☐ 220V DC ■ 415V 3 PHASE 3W ☐ 400V 3 PHASE 4W	
	NO. OF FEEDERS **(As per Electrical specification)**		☐ ONE ☐ TWO	
	STARTER WITH MCC		☐ REQUIRED ■ NOT REQUIRED	
	IPR POSITION		■ MCC ☐ RELAY PANEL	
	CONTACT RATING OF RELAY		■ 5 Amp, 230 V AC ■ 0.25 Amp, 220V DC	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		☐ REQUIRED ■ NOT REQUIRED	
	PAINT TYPE **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ EPOXY ENAMEL ☐ EPOXY POWDER COATED	
	MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		■ REQUIRED ☐ NOT REQUIRED	
	PANEL COLOUR (EXTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ LIGHT GREY ☐ OPALINE GREEN	
	FINISH (EXTERNAL) **(As per Annex-1, Section 7.6,Voulme IV of contract specification)**		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH (INTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	CLASS OF PROTECTION		■ IP-55 (FOR INDOOR SERVICE) ■ IP-67 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
	CONTROL HARDWARE		■ RELAY BASED	
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)		.....(Vendor to specify)	

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	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A
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		SHEET 2 OF 3

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement		
	CABLE GLAND	■ DOUBLE COMPRESSION		
	AMMETER (TYPE OF INPUT) *	☐ 1 Amp CT	☐ 4-20 mA	
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE	■ NA	
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL			

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI	NAME:
DESIGNATION	SR.ENGR	DY.MNGR	D. GM	
SIGNATURE				SIGNATURE:
DATE	16.09.2013	16.09.2013	16.09.2013	DATE:

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	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A	
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		SHEET 3 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION		❑ FOLDED ❑WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTACT RATING OF RELAY			
	TEMP SCANNER			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	TYPE OF MIMIC MATERIAL OF MIMC THICKNESS OF MIMIC			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			

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		SHEET 3 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

	PANEL TYPE		
	CABLE GLAND		
	AMMETER (TYPE OF INPUT)		
	SCOPE OF SUPERVISION		

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME	AANCHAL CHOUDHARY	SACHIN SRIVASTYAVA	MA MANSOORI	NAME:
SIGNATURE				SIGNATURE:
DATE	16.09.2013	16.09.2013	16.09.2013	DATE:

Instrumentation Quality Plan

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

LCP Quality Plan

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

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1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	3 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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SHEET	4 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
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SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	5 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
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SECTION	D
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SHEET	6 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	7 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

CABLE BOQ

CABLE SIZES FOR 5X800 MW YADADRI TPS	
Sl no.	Cable Type
	G-TYPE
1	2P X 0.5 sqmm
2	4P X 0.5 sq mm
3	8P X 0.5 sqmm
4	12P X 0.5 sqmm
5	2P X 1.5 sqmm
	F-TYPE
1	4P X 0.5 sqmm
2	8P X 0.5 sqmm
3	12P X 0.5 sqmm
4	20P X 0.5 sqmm
	CONTROL CABLE
1	3C X 2.5 sqmm
2	5C x 2.5 sq mm
3	12C x 2.5 sqmm

INSTRUMENT STUB DETAILS

CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, UNIT # 1 TO 5
CONSULTANT:	TATA CONSULTING ENGINEERS LIMITED BANGALORE, INDIA
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO. 417
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD

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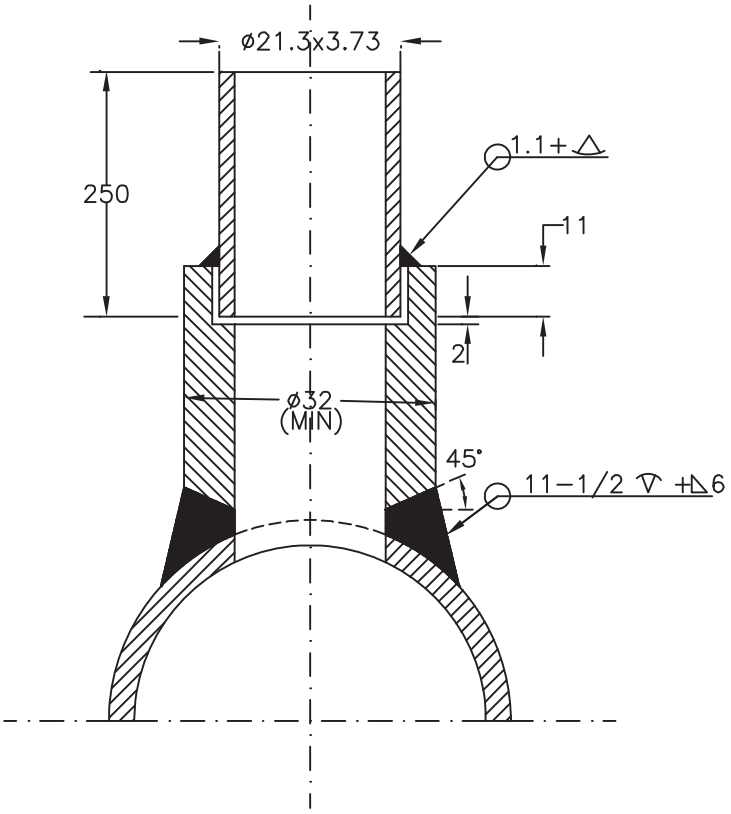
DEPT CODE		NAME	SIGN	DATE
I	DRN	AKS		20.01.18
	DESN	AKS		20.01.18
	CHD	RKR		20.01.18
	APPD	SSB		20.01.18

TITLE: INSTRUMENT STUB DETAILS

DEPT. SIGN SCALE

DRAWING NO. PE-DG-417-145-I101

SHEET 1 OF 6 REV. 00



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1/2" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATION VALVES ARE TO BE USED FOR PRESSURE EXCEEDING 40 Kg/Cm2.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

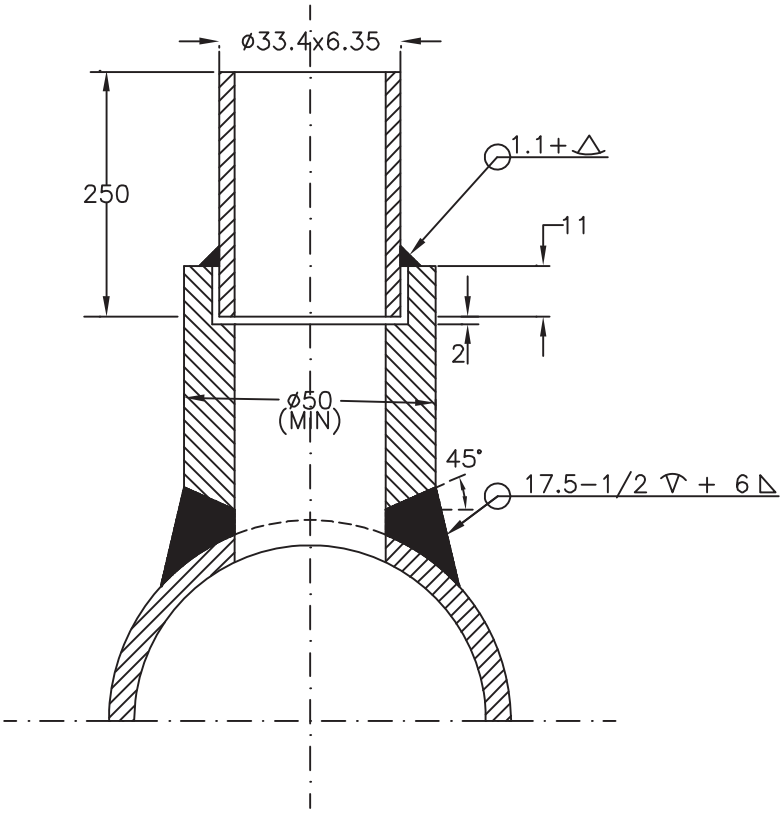
PRESSURE STUB

SYSTEM PRESS < 60Kg/Cm2 & SYSTEM TEMP<425 Deg C, Nb15 , CL3000

DRG. NO. PE-DG-417-145-I101

REV. 00

SH. 02 OF 06



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

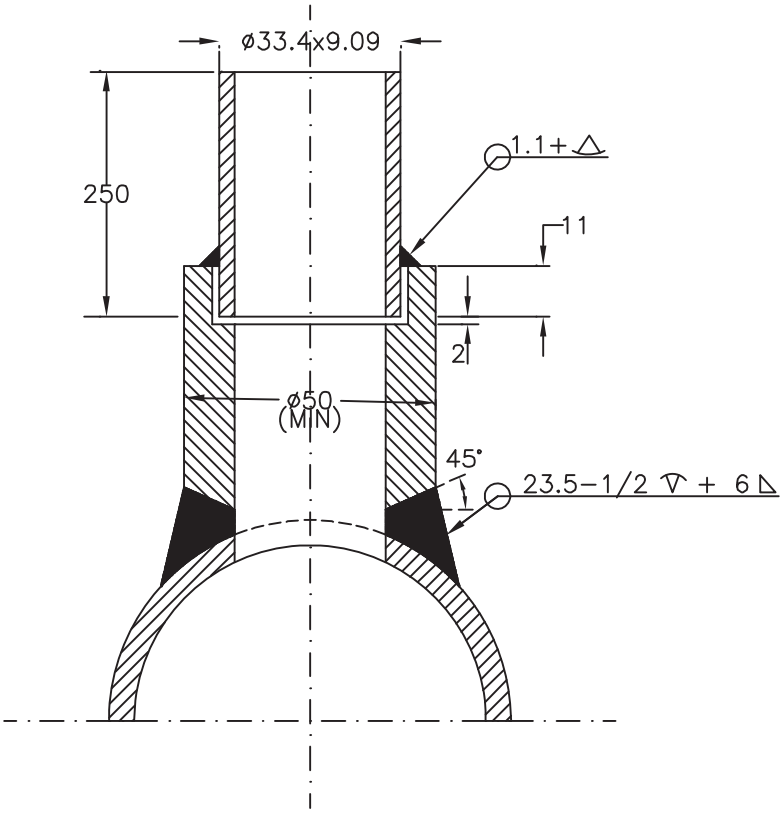
PRESSURE STUB

DRG. NO. PE-DG-417-145-I101

REV. 00

SH. 03 OF 06

SYSTEM PRESS > 60Kg/Cm2 & 425 Deg C < SYSTEM TEMP <= 500 Deg C , Nb25 , CL3000/6000



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

PRESSURE STUB

SYSTEM TEMP > 500 Deg C , Nb25 , CL9000

DRG. NO. PE-DG-417-145-I101

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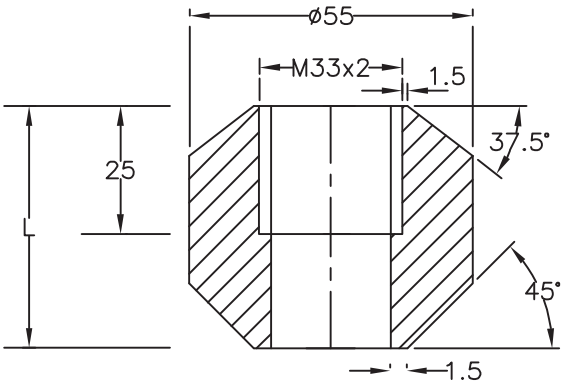
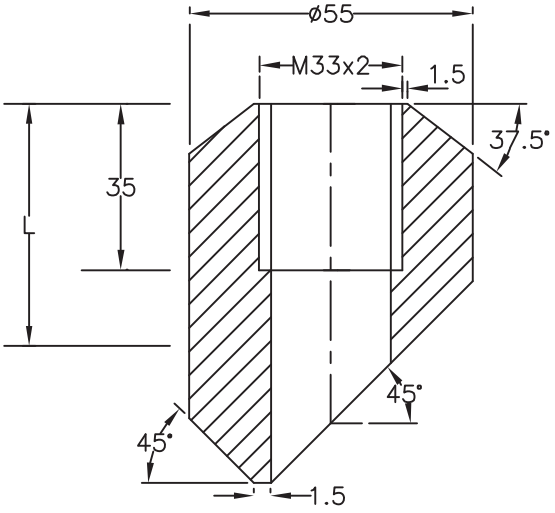


TEMPERATURE STUB FOR STRAIGHT IMMERSION



TEMPERATURE STUB FOR SLANT IMMERSION

NOTE :

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 64/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9 mm TO 159 mm STUB HEIGHT SHALL BE=64mm & FOR PIPE OD ⩾219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3 mm & ABOVE. THE STUB HEIGHT FOR PIPE OD 168.3 mm TO <219.1 mm SHALL BE 64 mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9 mm TO 159 mm.
5. FOR MAIN PIPE OD'S 88.9 mm & BELOW SUITABLE EXPANDER SHALL BE USED.
6. PLEASE REFER SHEET–6 FOR THERMOWELL INSTALLATION.

TITLE : 5 x 800 MW YADADRI TPS

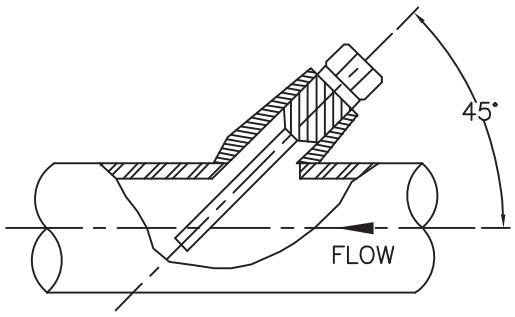
STD INSTRUMENT STUB DETAILS

TEMPERATURE STUB

DRG. NO. PE-DG-417-145-I101

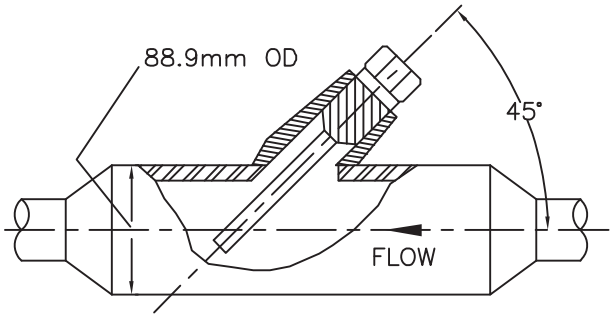
REV. 00

SH. 05 OF 06



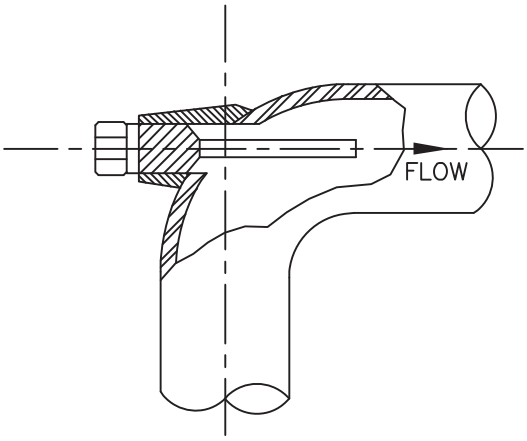
INSTALLATION TYPE–1

FOR MAIN PIPE OD 88.9mm to 159mm



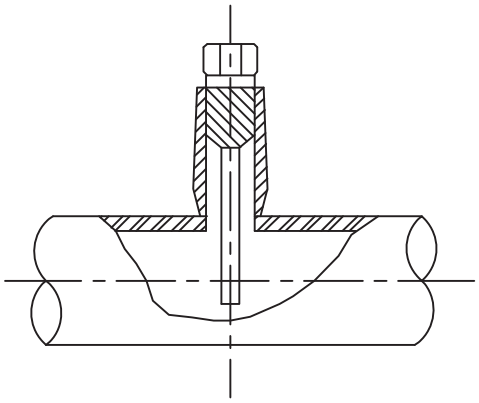
INSTALLATION TYPE–2

FOR MAIN PIPE OD BELOW 88.9mm



INSTALLATION TYPE–3

FOR MAIN PIPE OD 88.9mm & BELOW



INSTALLATION TYPE–4

FOR MAIN PIPE OD 168.3mm & ABOVE

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

THERMOWELL INSTALLATION

DRG. NO.
PE-DG-417-145-I101
REV. 00
SH. 06 OF 06

SECTION: I

SUB-SECTION: D

STANDARD TECHNICAL SPECIFICATIONS

STANDARD TECHNICAL SPECIFICATION FOR CENTRAL AIR-CONDITIONING PLANT

1. GENERAL

1.1 This specification covers the design, manufacture, testing at Manufacturer's works, delivery to site, handling at site, installation, commissioning and carrying out acceptance tests and final painting at site of various equipment of the central air conditioning plant, as specified hereinafter.

2. CODES & STANDARDS

2.1 The design, manufacture and performance of air conditioning equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment are to be installed. The equipment shall also conform to the latest applicable Indian/British/American standards. Nothing in this specification shall be construed to relieve the tenderer of this responsibility. In particular the equipment shall conform to the latest editions of the following standards.

2.1.1	IS-660	:	Safety code for Mechanical Refrigeration.
2.1.2	ARI 520-90	:	Standard for Positive Displacement Refrigerant compressors and condensing units.
2.1.3	IS-5111	:	Code of Practice of Measurement for Testing Refrigeration compressors.
2.1.4	ASHRAE/23-93	:	Method of Testing for Rating Positive Displacement Refrigerant compressors and condensing units.
2.1.5	ARI-450:		Standard for water-cooled Refrigerant condensers, Remote Type.
2.1.6	ASME (Section VIII)	:	Unfired pressure Vessels Code.
2.1.7	IS-2825	:	-do-
2.1.8	IS-4503	:	Shell and tube type heat exchangers.
2.1.9	ASHRAE/22-92	:	Method of Testing for rating of Water Cooled refrigerant condensers.
2.1.10	IS-659	:	Safety code for Air conditioning.
2.1.11	IS-2379	:	Color Code for Identification of pipe lines.
2.1.12	TEMA	:	Standards of Tubular Exchanger manufacturers Association.
2.1.13	IS-1239 (Part-I)	:	Seamless steel tubes (Up to & including 168.2 mm OD.).
2.1.14	IS-3589	:	For piping above 168.2mm to 2032mm Outside Diameter.
2.1.15	IS-778	:	Valves up to 50 MM.
2.1.16	IS-780	:	Valves 50 MM to 300 MM.
2.1.17	ASHRAE 24	:	Method of Testing for Rating liquid coolers.

2.1.18 ARI-480: Standard for refrigerant cooled liquid coolers-Remote type.

3. DESIGN & CONSTRUCTION REQUIREMENTS

3.1 The components of Central air conditioning plant comprising compressor, chiller refrigerant piping, valves and fittings etc. Shall be as given in Data sheet A. The type of all accessories, controls and instrumentation shall also be as indicated in data sheet A.

3.2 The various equipments supplied under this specification shall be fully compatible with each other & capable of operating as fully balanced integrated system to deliver the specified output under design conditions.

4. TESTING AND INSPECTION

(Refer standard quality plan)

4.1 Hydrostatic, Volumetric and refrigerant leak tests etc. shall be carried out at manufacturers works before dispatch of equipment in accordance with the applicable codes and standards.

Following minimum tests amongst others shall be conducted.

4.1.1 Material analysis, testing and identification (Data sheet/ Drg. Shall clearly indicate the specification, grade, class and Heat treatment condition of material for which TC will be furnished)

4.1.2 Hydrostatic pressure test of all pressure parts.(Testing pressure shall be clearly indicated for each component/ subassembly/ assembly)

4.1.3 Static and Dynamic balancing test of rotating parts at rated and over speed and to determine vibration & noise level.(Grade of balancing, type- whether dynamic or single plane balancing for components/ subassembly/ assembly shall be clearly indicated in data sheet/ approved drg.. Permissible vibration (velocity and displacement –peak to peak and noise level in dB(A) to be indicated in Data Sheet/Approved Drg.)

4.1.4 Radiography & magna-flux examination of materials & welds.(Components to be subjected to NDT with applicable, procedures and acceptance norms to be clearly indicated in Data sheet/ approved drg. If in a component only certain areas are to be subjected to NDT same shall be clearly brought out else it will be understood that the entire component is subject to NDT)

4.1.5 Ultrasonic test of castings & forgings.(Procedure and acceptance norms with areas subject to NDT to be clearly indicated in Quality Plan).

4.1.6 Performance test including determination of capacity, efficiency & characteristics etc.(Applicable standard, Acceptance norms, Procedure for test (if not covered in applicable standard),performance characteristics with applicable tolerances and drive to be used during shop test to be clearly indicated in Quality Plan). Performance data to be indicated in Approved Drg./ Data Sheet)

4.1.7 Functional checks and adjustments of controls & instrumentation. (Functional checks required to be clearly indicated with extent of check and applicable standard in approved check list / Quality plan. Class of instruments / tolerances and performance data to be incorporated in Approved Data Sheet / Drg.)

4.1.8 Checking of working clearances.(desired working clearances to be indicated in approved Drg.)

4.1.9 Examination after selective opening up after testing.(basis/ reasons for selective opening up, areas to be examined and parameters to be checked to be brought out in Quality Plan)

4.2 TESTS AT SITE

Tests to prove guaranteed performance of the air conditioning plant, shall also be carried out at site after proper installation. The site test shall include performance testing (as per FQP) of equipment for 72 continuous hours each in all three seasons i.e. Summer, Winter and Monsoon. Unless specified elsewhere. All instruments, tools etc. as may be required to carry out site tests shall be arranged by the tenderer.

5. PERFORMANCE GUARANTEE

5.1 Each equipment of air conditioning system shall be guaranteed for its rated capacity under the specified site conditions.

5.2 If the shop/site performance tests indicate failure of equipment to meet specified requirement, it would be tenderer's responsibility to carry out required alterations at no extra cost to purchaser. Tests shall be repeated after carrying out the modifications to demonstrate the performance.

5.3 The air conditioning plant before being taken over by purchaser shall be subjected to running test for a minimum period of one week during which all readings shall be recorded. Any deficiencies noted during this period, shall be rectified by the tenderer /at no extra cost to purchaser. These running tests shall be in addition to the seasonal performance test specified under clause 4.2. The inside design conditions shall be guaranteed throughout the year**.**

6. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

6.1

6.2 Drawings including equipment layout, foundation & loading details etc. for civil works for the entire plant. These drawings must cover sufficient details so that design of civil works can be completed.

6.3 Inspection, operation & Maintenance Manuals.

6.4 Manuals for method of testing & calibration of all instruments.

6.5 Equipment description giving complete design calculations, basis of design, selection criteria etc.

6.6 Schematic piping diagrams.

6.7 Layout of piping.

6.8 Electrical drawings.

6.9 Test Certificates.

6.10 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.

DESCRIPTION		DATA
1.	**GENERAL**	
1.1	Type of AC plant	: Chilled Water Type.
1.2	Plant configuration/capacity.	: Refer to Section-C of Specific Technical Requirements.
1.3	Location of AC plant rooms	: As per Tender drawings.
1.4		
1.5	Electrical work scope: -	
	i) MCC for AC plant	: By Others
	ii) Power cables / Control cables.	: By Others
	iii) Drives	: By Bidder.
	iv) Whether separate alarm/annunciation Panel/control panels required	: Yes (By bidder), Refer to Section-C of Specific Technical Requirements.
	v) Termination of cabling & earthling at Equipment end.	: By Bidder for bidder supplied equipment.
2.	**REFRIGERATION COMPRESSOR**	
2.1.	Type	: SCREW CHILLE
2.2.	Nos. (working + standby)	: Refer to Section-C of Specific Technical Requirements.
2.3.	Type of capacity control	: Automatic.
2.4.	Type of drive	: Direct driven.
2.5.	Restart after tripping	: Manual.
2.6.	Type of start	: As per manufacturing standard.
2.7.	Shaft Seal	: Mechanical shaft seal.
2.8.	Purge Recovery unit	: As per manufacturing standard.
2.9.	Type of lubrication	: As per manufacturing standard.
2.10.	Refrigerant used	: Environment friendly HCFC, (CFC is not acceptable)

3. DESIGN REQUIREMENTS

3.1.	Minimum capacity at Design conditions	: Refer to Section-C of Specific Technical Requirements.
3.2.	Capacity control	: Microprocessor based Control Panel sheet metal panel, located on each Compressor/chiller unit including protection devices
3.3.	Vibration isolator	:Neoprene rubber pads/Equivalent approved to suit chiller package.
3.4.	Type of foundation	: Floating / As per manufacturing standard

4.0 CONDENSER

4.1	Type	: Horizontal shell & tube type water-cooled
4.2	Number required	: One no. for each machine.
4.3	Design requirements	
4.3.1	Fluid	: Refrigerant (Shell side) Water (tube side)
4.3.2	Cooling Water Quantity	: To suit requirement.
4.3.3	Capacity of condensers	: To match compressor & to provide at least 2°C sub cooling.
4.3.4	Cooling water inlet temp.	: Refer to Section-C of Specific Technical Requirements.
4.3.5	Leaving Water Differential.	: Refer to Section-C of Specific Technical Requirements.
4.3.6	Max. flow velocity through tubes.	: 2.5 m/sec.
4.3.7	Design fouling factor	: 0.0002 (MKS Unit)
4.3.8	Maximum pressure drop.	: 0.6 Kg/cm2 (g)
4.3.9	Tube wall Thickness	: Not less than 18 SWG
4.4	Materials of construction	
	i/ Shell	: M.S. Plate fusion welded.
	ii/ Tube	: Integrally bonded Seamless copper

iii/ Head ends : Cast Iron.

iv/ Tube sheet material : Steel

v/ Baffle plate : Steel.

4.5 Accessories required

i/ Purge & drain connections with valves. : Yes

ii/ Relief valves : Yes

iii/ Liquid line shut off valve. : Yes

iv/ Isolating valves on water side. : Yes

v/ Flow switch : Yes (interlocked with control of individual refrigeration system)

vi/ Pressure/temperature gauges at inlet/outlet : Yes

vii/ Descaling tee : Yes

viii/Charging valve : Yes

ix/ MS supporting frame work : Yes

viii/Cooling thermostat : Yes

ix/ MS supporting frame work. : Yes

5.0 **CHILLER** (Applicable for chilled water type plant only.)

5.1 Type : Horizontal shell & tube flooded type

5.2 Number required/standby : One no. for each chiller package.

5.3 Design requirements

5.3.1 Fluid to be cooled : Water

5.3.2 Water flow rate (Inside tube) : To suit requirement.

5.3.3 Water inlet temperature : 12 ^{o}C approx.

5.3.4 Water outlet temperature : 7 ^{o}C approx.

5.3.5 Super heating of refrigerant material : By at least 3 deg. C.

5.3.6 Insulation /thickness/finish : As per the manufacture standard.

5.3.7 Design fouling factor : 0.00010(MKS Unit)

5.3.8 Maximum pressure drop. : 0.6 Kg/cm2 (g)

5.3.9 Tube wall Thickness : Not less than 22 SWG.

5.4 Materials of construction

i/ Shell : M.S. Plate fusion welded.

ii/ Tube : Integrally Seamless copper (internally Corrugated)

iii/ Head ends : Cast Iron.

iv/ Tube sheet material : Steel.

v/ Baffle plate : Steel.

5.5 Accessories required

i/ Purge & drain : Yes

ii/ Gate valves at water inlet/outlet. : Yes

iii/ Flow switch : Yes

iv/ Pressure/temperature gauges at inlet/outlet : Yes

v/ Anti-freeze thermostat : Yes

vi/ Thermostatic expansion valves : Yes

vii/ Pilot solenoid valve : Yes

viii/ Cooling thermostat : Yes

ix/ MS supporting frame work. : Yes

Note :-

The system shall also incorporate:

1) Auto operation of chilling plant for operation of the whole AC system.

2) A Central Control Panel with fault annunciators with provision for remote extension besides local control kiosks.

3) Water Chiller package shall be skid-mounted unit with microprocessor based control panel complete with all accessories and controls are assembled at manufacturing works on single unit.

4) Screw chiller shall be suitable for 415V $\pm$ 10 %/50 Hz $\pm$ 3%/3 phase operation with voltage & frequency variation as specified with built in starter etc.

5) Only supply feeders shall be provided for chillers.

STANDARD TECHNICAL SPECIFICATION
FOR
AIR HANDLING UNITS

1. GENERAL

1.1 This specification covers the design, manufacture, Construction features, installation, commissioning, inspection and performance testing at site of AHUs.

2. CODES AND STANDARDS

2.1 The design manufacture and performance of AHU shall comply with all currently applicable statutes, regulations and safety codes in the locality where the AHU is to be installed. The equipments shall also conform to the requirements of the latest editions of applicable Indian/British/US standards. Nothing in this spec. shall be construed to relieve vendor of this responsibility. In particular the equipment shall conform to the latest editions of the following standards:

2.1.1 IS-659 : Safety code for air conditioning

2.1.2 IS-660 : Safety code for mechanical refrigeration

2.1.3 ASHRAE: Method of testing forced circulation air-cooling and air heating coils. standard 33

2.1.4 ARI 41 : Standard for forced circulation air cooling and air heating coils.

2.1.5 ARI 430/435 : Air-cooling and air heating coils Central Station AHU / Application of Central Station AHU.

2.1.6 AMCA : 211 and 311

In case of any conflict in the standards and this specification the decision of PEM,BHEL shall be final and binding.

3. CONSTRUCTION FEATURES

3.1 The casing of AHU shall be made of insulated double wall construction of min. 24 gauge galvanized sheet steel - IS 277 Gr. 120 (parent sheet: D/DD-IS-513) ribbed and reinforced for structural strength and rigidity with 25 mm thick polyurethane insulation of minimum 40 kg/m^3 density in between. The external wall will be pre-plasticised over GI coating on the outside. Angle irons or channel sections made of 16 gauge galvanized sheet steel shall be used for reinforcing. The casing shall be of sectionalized construction with proper sealing at the joints to make them air tight. Fan section and panels with bearing support shall be reinforced with heavy gauge channels (min. 5 mm thick). Suitable number of forged hot dip galvanized (610 gm/sq.m) U brackets shall be provided for AHU suspended from ceiling/roof.

Necessary arrangement shall be provided on the casing for measuring temperature and pressure in cooling/heating coil. Class of instruments shall be min. 2.

3.2 Fan impeller shall be forwardly/backwardly inclined curved blade centrifugal type. Impeller shall be double width double inlet type. Fans shall be preferably low rpm (<=1500) to minimize vibration and noise. Noise shall be within 85 dB(A) at 1 metre distance from AHU casing. Max. Vibration level shall be acceptance and norms to be specified. Two to three wheels (impellers) shall be provided for each AHU. Impeller blades shall be fabricated from (min. 1.0 mm) galvanized/ epoxy powder coated sheet steel. Fan shall be of epoxy powder coated / galvanized sheet steel (min. 1.6

mm) scroll with die formed inlets for uniform air flow. Fan shafts shall be solid cold rolled carbon steel (EN8 normalised), ground and polished. Fan shaft bearings shall be of heavy duty type selected for average operating life of 100,00 hours. Bearings shall be self-aligning, permanently lubricated type. Make of Brgs(SKF/FAG/NORMA/TATA) to be specified. Bearing Housing shall be of casting of min. IS Gr. 210, split type and suitably supported. The V-belt drive with belt guard shall be provided. Motors shall have minimum 15% margin over maximum BHP in working range.

3.3 DX or chilled water cooling coils and steam/hot water coils shall be internally corrugated copper/ cupronickel tubes (as per manufacturer's standard) with smooth non corrugated external fins of aluminium (thickness 0.14 mm and grade 1100 as per spec) unless specified otherwise in specification. At least 5 fins /per cm. shall be provided. The chilled water/hot water coils shall have suitable (standardize class, size, threading) drain and vent connections.

3.4 The filters in the filter section shall be provided as detailed in data sheet A.

3.5 Humidifier shall be Pan type/as specified in the specification.

Pan type Humidifier consisting of SS304/316 tank, heater, geyserstat with piping connection to supply air duct shall be provided unless specified otherwise in data sheet A.

Heaters and branch line shall be of galvanized steel and nozzles shall be of brass (matl. grade) /SS 304.

3.6 Condenser water from coil or surplus water from spray humidifier shall be collected in 16 gauge SS-304 pan. Minimum 50mm dia GI pipe nipple shall be provided on each end for drain connection. The drains for these points shall be extended to the main drain in AHU room.Condensate drain pipe (GI) of required length with sealing loop shall be provided and insulated as specified in the specification for insulation. Minimum requirement For GI Pipes and fittings shall be ERW/Seamless of medium thickness as per IS-1239/3589 and Hot dip galvanized

3.7 Suitable number of Spring type vibration isolators shall be provided for fan and motor assembly. Neoprene rubber pads shall be provided below the AHU.

The AHU shall be provided with 18 G SS drain pan.

4. **TESTING AND INSPECTION AT MANUFACTURERS WORKS:**

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection.

4.1 Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.

4.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating. For pipes and fittings compliance report shall be furnished by Manufacturer for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

4.3 Shaft: Mechanical and chemical.

4.4 Motors (of approved make): Routine TC.

4.5 Workmanship and dimensional check as per manufacturing drg. and approved Drgs.

4.6 Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked to avoid loosening. Balancing weights and fasteners used shall be galvanized.

4.7 Performance test of one Centrifugal fan/per type/per size as per AMCA standard (for indigenous make).

4.8 Centrifugal fans for AHUs will be 100% run tested by main contractor of BHEL. One centrifugal fan/per type/per size will be run tested. Vibration shall be within good zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.

4.9 Complete assembly of one AHU/per type/ per size (excluding cooling coil and filter) shall be witnessed.

4.10 Run test of one complete assembly/per type/per size (excluding cooling coil and filter). Vibration shall be within satisfactory zone of VDI 2056 / ISO 10816-1(group-K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.

5. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

5.1

5.2 Drawing including equipment layout, foundation & loading details etc. for civil works. These drawings must cover sufficient details so that design of civil works can be completed.

5.3 Inspection, operation & Maintenance Manuals.

5.4 Equipment description giving complete design calculations, basis of design, selection criteria etc.

5.5 Test Certificates.

5.6 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.

5.7 Performance Test Certificates.

DESCRIPTION		DATA
1.	Nos. required/working	: Refer to Section-C of Specific technical requirement.
2.	Location	: Refer to Section-C of Specific technical requirement.
3.	Service/type	: Air Conditioning /Double skin.
4.	Fan type	: Centrifugal (forward/backward curve Blade) limit load.
	a) Capacity	: To Suit as per calculation.
	b) Static pressure	: To suit but not less than 60 mm wc for AHU's Micro-V filters.
	c) Discharge direction	: To suit layout.
	d) Motor	: By Bidder,
	e) Local push button station (Start/Stop)	: By Others
	f) Motor location	: Inside AHU Casing.
	g) Drive	: Belt, pulley, belt guard.
5.	Face and Bypass Damper	: Required (Opposed blade type) DX AHU's having
6.	Cooling coil	
	a) Duty sensible heat	: To suit as per calculations
	b) Duty latent heat	: -do-
	c) Type of coil	: Chilled Water/DX/Hot Water.
	d) No. of rows	: To suit but not less than four (4)
	e) Material of tube /Thickness	: Seamless Copper to ASTME-75/Equivalent.
	f) Material of fins	: Aluminium to SAE-1100-/1145-0
	g) Number of fins	: Not greater than 5 per cm (13 per inch).
	h) Max. face velocity	: 2.5 m/sec.
	i) Air flow quantity	: To suit as per tender drawings/documents.
7.	3 - way motorised mixing valve with thermostat.	: Required with thermostat & actuator for chilled water system for each AHU.

8.	Damper at discharge	: Manually operated at discharge of each AHU outlet.
	a) Material of construction	: Mild Steel, galvanised.
9.	Filters (Pre-filters)	
	a) Type & thickness	: Dry panel type/ 50 mm
	b) Filter area.	: To suit as per velocity requirements. "V" - Bank.
	c) Filter efficiency	: Average arrestance efficiency of 65-80 %
	d) Press drop (Clean)	: Not to exceed 2.5 mmwc when clean & 6.5 mmwc while dirty.
10.	Humidification section	: As per the System requirement.
	a) Type	: Pan type, unless otherwise specified.
	b) Operation	: Automatic with Humidification.
11.	Fresh air arrangement	: Required.
	a) Fresh air fan	: Tube axial flow fans with motor.
	b) Accessories	: i) Inlet cone with Bird screen. : ii) Dry panel pre-filters, : iii) High efficiency filters for control room areas. : iv) Volume Control Dampers, : v) Supports etc.
12.	Vibration isolator required.	: Yes
13.	Type of vibration isolator.	: Neoprene ribbed Rubber for AHU's.
14.	Any other requirement	: i) In addition to dry panel filters on AHU, High efficiency filters(average arrestance efficiency of 80-90 %) shall be provided in supply air duct side of AHU for all control room and allied areas. : ii) Bidder to also provide suitable electrical strip heaters for winter heating & monsoon reheating with Contactor box etc. Heaters to be interlocked with airstat.
15.	Instrument & controls	: Lot.(including Control box for strip heaters, pan humidifiers etc. in each AHU room.)
16.	Insulation of drain piping	: Lot.

STANDARD TECHNICAL SPECIFICATION
FOR
COOLING TOWER

1. GENERAL

1.1 this standard specification covers the design, manufacture assembly, inspection & testing at manufacturer's works, suitable painting & packing, delivery, erection & commissioning at site of all materials and equipments for mechanical induced draught cooling tower complete with all accessories as specified hereinafter.

2. CODES & STANDARDS

2.1 the design, manufacture, inspection & testing and performance of the cooling tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American standards and codes of practice. the latest editions of the following standards & publications shall be followed in particular:

2.1.1 Cooling tower institute USA bulletin ATP-10S: Acceptance test procedure for industrial water-cooling tower.

2.1.2 PTC-23 ASME performance test code for Atmospheric water-cooling equipment.

2.1.3 In case of any conflict between the above codes & standards and-this specification, the later shall prevail.

3. DESIGN REQUIREMENTS

3.1 the cooling tower shall be designed for continuous operation to cool not less than design flow of water from specified inlet temperature to the outlet temperature at a design ambient wet bulb temperature as indicated under data sheet a.

3.2 all the components shall be capable of safe, proper and continuous operation at all cooling water flows upto & including those specified under data sheet a & shall be designed with regard to case of maintenance, repair, cleaning & inspection.

3.3 the cooling tower shall be of induced draught cross flow or counter flow type and with multiple cells (if specified in data sheet a.) the cooling tower shall be suitable for handling the fluid and also for achieving the specified parameter as per data sheet a. the cooling tower shall be designed such that the drift losses & evaporation losses are minimum.

4. CONSTRUCTIONAL FEATURES

4.1 CASING & LOUVERS

4.1.1 The cooling tower casing shall be made of FRP/as specified in data sheet A. The louvers shall be made of FRP/as specified. Louvers, if provided, shall be designed for air entry to the tower with low velocity for minimum pressure drop & less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards. Air intake shall be all along the base circumference of the casing & hotdip galvanised expanded metal mesh shall be provided to protect the air intake.

4.2 FILL

4.2.1 Cooling tower fills shall be made of noncombustible PVC/as specified in data sheet A. The design & arrangement of the fills shall be so as to expose maximum air/water surface with minimum pressure drop.

4.3 Drift Eliminators

4.3.1 Multi-pass drift eliminators with minimum two pass zig-zag path shall be provided so to minimise the drift losses.

4.3.2 In case of FRP cooling tower the drift eliminators shall be of multi-blade rotary type.

4.4 Fans & Accessories

4.4.1 The fans shall be multiple blade, low speed, high efficiency axial flow type located above the top deck level of the cooling tower. Fan rotating assembly shall be statically & dynamically balanced. The fan blades shall be preferably adjustable in stand still condition for propeller action. The fan shall be either directly mounted on the shaft of a totally enclosed weather proof motor or shall be suitable for V-belt drive.

4.4.2 The rating of drive motor shall have at least 15% margin over maximum fan power consumption. The design & construction of the drive motor shall be in accordance with enclosed specification for LVAC motors.

4.5 Water basin

4.5.1 The material of construction of water basin shall be FRP or RCC as specified in data sheet A. The basin shall be provided as a part of cooling tower in case of FRP construction. The sump shall have sufficient storage capacity for safe operation of AC plant.

4.6 Hot water distribution system

4.6.1 Manually operated flow control valves shall be provided in hot water distribution piping such that each cooling tower can be isolated without affecting the operation of other cells.

4.6.2 The nozzles shall be spaced to give even distribution of water over entire space occupied by top row of fills. The nozzles shall be made of brass /SS 304/316/316L (brass shall be as per manufacturer's standard) unless specified in data sheet A:

4.6.3 In case of FRP tower water shall be distributed over the fill by means of a multiple area fail safe rotary sprinkler made of PVC pipes fitted on a aluminium alloy (as per manufacturers standard) rotary head and mounted on sealed ball bearings (make) .

4.7 Access

4.7.1 A stair case paddle ladder (as per manufacturer's standard) shall be provided external to the cooling tower at one end of each tower along with stairways hand rails etc give safe & convenient access to the top deck from ground level.

4.8 Painting

4.8.1 The cooling towers shall be painted with suitable anti-corrosive paint as per approval of purchaser. All galvanized external surfaces shall be painted to match colouring scheme. Before painting galvanized surfaces -etch primer to be applied.

5. SHOP INSPECTION & TESTING

5.1 Compliance certificates for nozzles (Or rotary sprinkler), piping, fill material, drift eliminator, louvers components etc.

5.2 Certificate of conformance for all other material components.

5.3 Balancing report for Static & dynamic balancing of fan assembly.

6. TESTS AT SITE

6.1 Hydrostatic testing of complete hot water distribution piping at site.

7. PERFORMANCE GUARANTEE

7.1 The cooling tower shall be guaranteed to meet the performance requirements as specified & when tested in accordance with ATP-105.

7.2 The vendor shall furnish performance curves for the cooling tower showing variations in performance from design duty point with change in approach to wet bulb temperature, cooling range, water loading of cooling tower.

8. DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT

8.1 General arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions, limits of scope of supply of piping, limits of civil works included showing extent of platforms, walkways, handrails, access doors, staircase etc. and the limits of scope of supply of electrical works.

8.2 General arrangement and sectional assembly drawings pertaining to the following components of the cooling tower:

i) Tower fill with supporting arrangement.
ii) Drift eliminator installation and details.
iii) Complete hot water distribution system including flow regulating valves, distribution basin/pipes and nozzles etc.

8.3 Cooling tower performance curves showing WBT Vs cold-water temperature for design cooling range, 90% cooling range and 110% cooling range at 100%, 90%, and 110% design flow.

8.4 Performance curves of cooling tower fans.

8.5 Test procedure along with details of tests to be conducted for the offered cooling tower.

8.6 Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.

8.7 Operation and maintenance instructions.

A. **GENERAL DATA**

1)	Service	: Cooling of condenser water of AC plant.
2)	Type	: Fibreglass reinforced plastic construction induced draught.
3)	Quantity	: Refer to Section-C of Specific Technical Requirements.
4)	Place of installation	: Refer to Section-C of Specific Technical Requirements.

B. **DESIGN DATA**

1)	Capacity at specified conditions.	: To suit the system requirement.
2)	Water flow rate	: To suit the system requirement.
3)	Design wet bulb temperature	: 25 Deg. C.
4)	Hot water inlet temperature	: To suit requirement.
5)	Cooled water temperature	: To suit requirement.
6)	Depth of sump Tank	: As per manufacturer's standard.

C. **MATERIAL**

1)	Sump tank & Casing	: FRP
2)	Louvers	: FRP/PVC/Aluminium.
3)	Type of fill	: Non-combustible PVC/Eq.
4)	Nozzles	: Brass with chrome plating/polypropylene.
5)	Ladder	: Hot dip galvanized steel ladder for each tower.
6)	Bird screen	: 25 mm square made of GI/SS wire mesh of 16 gauge.
7)	Fan impeller	: Cast Aluminium Alloy/FRP propeller type and multi-blade aerofoil construction with adjustable pitch..
8)	Supporting structure	: MS with spray galvanization of epoxy painting.
9)	Strainer	: Plant strainer made of GI/SS wire mesh of 16 gauge.

D. ACCESSORIES

1)	Make up connection	: Yes.

2)	Quick fill connection	: Yes.
3)	Overflow & drain & blow down connection	: Yes.
4)	Access door in louvers/fan deck	: Yes (if applicable).
5)	Supports & supporting structure for mounting	: Yes.
6)	Level switch	: Yes.
7)	Rain protection for motor	: Yes (suitable Canopy by Bidder)
E.	ELECTRICAL DATA	
i)	Power supply	: 415 V$\pm$ 10%/50 Hz $\pm$ 3%/3 phase.
ii)	Motor	: As per specification attached.
F.	INSPECTION & TESTING	: As per approved quality plan.

STANDARD TECHNICAL SPECIFICATION
FOR
LOW PRESSURE AIR DISTRIBUTION SYSTEM

1. GENERAL

1.1 This specification covers the design, manufacture, construction features, installation, inspection testing and air balancing of air distribution system upto a total pressure of 95mm w.g. The specification is intended to cover the air distribution for air conditioning system and ventilation system not involving localised exhaust.

2. CODES AND STANDARDS

2.1 The design, construction and performance of complete system shall conform to all currently applicable stuatues, regulations, safety codes in the locality where the equipment are to installed

2.2 Unless specified otherwise the equipments shall generally conform to latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall generally conform to latest editions by the following standards:-

a) IS: 655 - Specifications for metal air ducts.

b) IS:277 - Specifications for galvanised steel sheets.

c) IS:737 - Specification for wrought aluminium and aluminium alloy sheet and strip.

3. MATERIAL

3.1 Metal air ducts shall be either of galvanised steel sheets or aluminium sheets, as indicated in data sheet-A.

3.2 The rolled steel sheets before galvanising shall be properly annealed or normalised so as to allow fabrication of ducts without developing cracks. Zinc coating on the steel shall be as per technical requirement refer to Section-C of Specific Technical Requirements.

3.3 The aluminium sheets shall be of grade S1C or NS3 and shall be suitable for duct fabrication work as per IS-737 latest

4. CONSTRUCTION/FABRICATION

4.1 The thickness of sheets, the type of bracing and other fabrication details shall generally conform to requirements given hereunder unless specified otherwise in data sheet A and/or indicated on drawings.

4.2 **RECTANGULAR DUCTS**

4.2.1

S.No.	Max Side	Sheet Thickness	Type of transverse	Bracings

		(mm) GI	(mm) Al	Joint connections	
a)	Up to 600	0.63 (24G)	0.80	S-drive, pocket or bar slips or flanged joints on 2.5m centres	None
b)	601 to 750	0.63 (24G)	0.80	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
c)	751 to 1000	0.80 (22G)	1.00	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
d)	1001 to1500	0.80 (22G)	1.00	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips with 35x3mm bar reinforcing on 2.5m centres	40x40x3 mm MS angles, 1.2m from joints
e)	1501 to2250	1.00 (20G)	1.50	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips, 1M maximum centres, with 35x3mm bar reinforcing	40x40x3 mm diagonal angles or 40x40x3mm angles, 600mm from joints
f)	2251 & above	1.25 (18G)	1.80	50x50x3mm MS angles,connections or 40mm pocket or 40 mm bar slips, 1M maximum centres with 35x3mm bar reinforcing.	50x50x3mm diagonal angles or 50x50x3mm angles 600 mm from joints.
g)	No bracing is required if transverse joints are less than 600mm apart				
h)	For ducts larger than 2250mm, special handling and supporting methods shall be provided as per the approval of Purchaser				

4.2.2 All rectangular ducts having either dimension larger than 450mm shall be cross broken except these ducts which are insulated with sand cement plaster. Air outlet connections on ducts need not be cross broken.

4.2.3 The seams on duct cones shall be of Pittsburgh type. Longitudinal seams shall be smooth inside the ducts.

4.2.4 The flanges used for transverse joints shall be joined together with GI bolts (grade 4.6) and nuts spaced at 125mm centres as per following:

a) Upto 1000mm - 6 mm dia GI bolts
b) 1001 to 1500 - 8 mm dia GI bolts
c) 1501 and above - 10mm dia GI bolts

4.2.5 The MS angle flanges shall be connected to ducts with rivets at approx. 100mm centres. The flanged joints shall have 6mm thick felt packing stuck to flanges with shellac varnish. The holes in the felt packing shall be burnt through. The ducts are to be tapped 6mm across the MS flanges.

4.2.6 MS angles used for bracings shall be tack welded to the ducts or rivetted at 125mm centres, as applicable.

4.3 **ROUND DUCTS**

4.3.1

S.No.	Duct dia-mm	Sheet Thickness		Reinforcing
		(mm) GI	(mm) Al	
a)	Up to 150	0.63 (24G)	0.80	None
b)	151 to 600	0.80 (22G)	1.00	None
c)	601 to 1000	1.00 (20G)	1.50	40x40x3mm girth MS
d)	1001 to1250	1.00 (20G)	1.50	40x40x3mm girth MS angles at 2.0 meter centres
e)	1251 & above	1.25 (18G)	1.80	40x40x3mm girth MS angles at 1.2m centres

4.3.2 The seams on round ducts may be continuously welded or grooved longitudinal seam. In case of welding of GI sheet, zinc rich paint shall be applied on the welded zone.

4.3.3 Round ducts shall either be joined by welding or the ducts shall be swedged 40mm from the ends such that larger end will butt against the swedge and is held in place with sheet metal screws.

4.4 **DUCT SUPPORTS**

Unless specified otherwise on drawings, rectangular ducts with larger side of 2250mm or above shall be supported by 15mm MS rods and 50x50x3mm and MS angles while those below 2250 mm shall be supported by 10mm MS rods and all angles shall be given a coat of primer paint. The duct supports shall be at a distance not exceeding 1800mm. The MS rods shall be fixed to MS angle cleats, which in turn are fixed to ceiling slab by suitable anchor fasteners. All anchor fasteners, MS angle cleats, coach screws, hooks and other supporting material required shall be provided by vendor.

However, If ducts are thermally insulated, the MS angles and supports shall not be in

direct contact with ducts, for which purpose wooden pieces/ Resin bonded fibre glass sheets (50 mm thick) shall be used in between.

4.5 **FLEXIBLE CONNECTIONS**

Wherever the sheet metal ducts connects to intake or discharge of fan units a flexible connection of at least 150mm width made by closely woven double layer Fire resistant or canvas shall be provided. The same shall be attached to angle iron frames on equipment and to similar frame on duct or casing by means of a steel band 9r (or) collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between the band and the angle frame.

4.6 **TRANSFORMATIONS AND BREACHES**

All curves, bends, offsets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have a velocity not exceeding that in the main duct to which the branch is connected.

4.7 **CAULKING**

Wherever duct passes through wall, the opening between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to adjoin by space with a rated fire resistant material.

4.8 **EASEMENT**

Normally pipe hangers, light fitting rods etc. shall not be allowed to pass through the ducts. Wherever, It becomes absolutely essential to pass these hangers/rods etc. Through the ducts, prior approval of purchaser shall be taken and light streamlines easement around the same shall be provided to maintain smooth air flow.

4.9 **ACCESS DOORS**

Access doors shall be provided in ducts, plenums etc. on both sides to allow access and servicing of equipment viz. pipes, dampers, coils, valves, heaters etc.

All access doors shall be adequately sized and lined suitably with felt to prevent air leakage. The doors shall be of built-up construction, structurally strong and shall have at least two hinges each, and shall be with two rust proof window sash locks of approved type. All doors shall be so set as to flush with outer finish of duct insulation etc.

4.10 **DAMPERS AND SPLITTERS**

4.10.1 Dampers and splitters shall be provided at suitable points for proportional volume control of the system. Splitters and dampers shall be made of minimum 18 gauge GSS of quadrant type with locking device mounted outside the duct at accessible location.

4.10.2 FIRE DAMPERS

Fire dampers shall be provided as specified in Data Sheet -A and shall be installed at locations indicated on drawings and/or as required/approved by purchaser, including all openings in passage of duct work through fire walls and floors etc. The fire damper shall be of electrical type with damper motor actuated by thermal

sensor or fusible link type.

4.10.3 VANES

Unless otherwise shown in the drawings all elbows shall be such that the throat radius is 75% of the duct width. In case throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

4.10.4 FLASHING

For the ducts penetrating roofs or outside walls, provision of flashing shall be made by the ducting vendor.

4.11 **DIFFUSERS AND GRILLS**

The type and quantity of diffusers and grills is indicated on enclosed drawings/data sheet A. The size/quantity of diffusers/ grills indicated in the drawing/data sheet is indicative and is for vendor's reference purpose only. Vendor shall ensure that the diffusers/grills offered are of requisite capacity, throw and terminal velocity. The pressure drop and noise levels shall be as per data sheet. A enclosed. The diffusers/grills shall be approved by purchaser.

Unless specified otherwise the diffusers/grills shall be of mild steel land painted with two coats of primer paint. Supply air grills shall be complete with volume control dampers. Supply air grills shall be double deflection type while Return Air grills can be single deflection type. Ceiling outlets/diffusers shall have volume control dampers, fixed grids and blanking baffles. All volume control dampers shall be operated by a key from the front of grills/diffusers.

Suitable vanes shall be provided in duct collars to have uniform air distribution. Blank-off baffles wherever required, shall also be provided.

4.12 **PLENUMS AND RA BOXING**

All plenum chambers and/or connections to fans, dampers etc. shall be constructed in 18 gauge GI sheet. supported on 40x40x6mm MS angle frames. All vertical angles shall be riveted at appox. 125mm. centres to the casing. Suitable caulking compound (Pecora or equivalent) shall be inserted between the base of the angle and all masonary construction to which angles are fastened.

Return air boxing requirements if any are indicated in data sheet-A and the same shall be provided by vendor. The return air box ~~shall be~~ fabricated out of GI sheets shall be insulated with 25mm thick fibre-glass.

4.13 **ACCOUSTIC LINING**

The ducts shall be lined acoustically from inside as given in data- sheet A and/or section C of the specification.

4.14 **PAINTING**

Wherever specified the ducts shall be painted or lined with suitable anti-corrosive paint/ lining as per approval of purchaser. In particular the ducts coming in contact with acid fumes shall be epoxy coated, inside and outside.

4.15 **THERMAL INSULATION**

Thermal insulation shall be as per data sheet - A and the insulation shall conform to enclosed spec. no. PES-553-08.

5. INSPECTION AND TESTING

5.1 **INSPECTION & TESTING DURING FABRICATION**

5.1.1 Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.

5.1.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

5.1.3 Check for dimensions & mass as per latest IS-277.

5.1.4 Check for defect, twists, ungalvanised spots as per IS-2629.

5.1.5 Bend test & wrapping test as per IS-277.

5.1.6 Zinc coating test on samples as per IS-6745.

5.2 **INSPECTION & TESTING AT SITE.**

5.2.1 The duct branches, elbows etc. shall be inspected and the joints and connections etc, are to be checked before they are assembled in position.

5.2.2 After completion, all duct systems shall be checked and tested for air leakage, tightness, velocity, pressure drop, vibration and noise etc.

6. BALANCING

6.1.1 The entire air distribution system shall be balanced by vendor to supply the air quantities as required in various rooms so as to maintain the requisite temperature and air flow in the conditioned spaces. The final balance of air quantities through each grill/diffuser etc. shall be recorded and submitted to purchaser for approval. Proper steps shall be taken to have a uniform temperature in all enclosures, with utmost care for noise level to be within tolerance limit

6.1.2 All instruments required for testing/balancing etc. of the air distribution system shall be provided by vendor.

7. DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT

7.1 Fabrication drawings of ducts and grilles, louvers, dampers, etc, including typical details of grilles dampers etc.

7.2 Test certificates in line with scope of inspection.

7.3 Other dimensional drawings & documents as may be required by purchaser for better understanding of the system & for preparation of operation, maintenance & instruction manual.

Description	Data
1. General (List of areas)	: As per Specification/Tender drawing.
2. GSS Duct Work	
a) Type	: GSS as per IS: 277 (Zinc coating as per Section-C of Specific Technical Requirements.)
b) Size	: As per Section-C of Specific Technical Requirements and bill of quantity.
3. Acoustic lining	: Up to 5m length from AHU Outlet.
4. Special painting	: Galvanised.
5. Thermal Insulation	: Required in supply air duct in AC entire length.
6. Diffusers (Circular/Square)	
300 mm size 350 mm size 450 mm size 550 mm size 600 mm size Any other size	: Bidder to estimate as per drawings./specification. All grille frame and louvers shall be manufactured of at least 16 SWG Aluminium
7. SA grilles (for each size)	: To suit air flow as per System requirements / Tender Drawings.
8. RA grilles (for each size)	: -do-

NOTE:

1. Duct sheet thickness shall be as per IS-655
2. Opposed blade type volume control damper shall be provided at each supply air diffusers/grilles.
3. Bidder to provide suitable gasketing at each duct flange.
4. Fire damper shall be motor operated type, when otherwise specified under Section-C.
5. Access door in ducting system shall be provided as required.
6. MS Angle (painted) shall be used for duct supports etc.
7. Velocity thru duct shall normally not exceed 9.0 M/sec for Air conditioning system. Maximum velocity (outlet) for supply air diffuser shall not exceed 2.5 m/sec.

8. All Grilles & diffusers shall be supported with frame. Frame etc. shall be supplied by bidder.

STANDARD TECHNICAL SPECIFICATION
FOR
CENTRIFUGAL PUMPS

1. GENERAL

1.1 This specification covers the design, material, constructional features, manufacture, assembly, inspection and testing at manufacturer's or his subcontractor's works, suitable painting requirements of centrifugal pumps and drives complete with all accessories as specified hereinafter.

2. CODES AND STANDARDS

2.1 The design, manufacture, inspection, testing & performance of the pumps as specified hereinafter, shall comply with the requirements of the latest revision of the following standards as indicated below (as applicable):

2.1.1 IS-1520 : Horizontal centrifugal pumps for clear, cold and fresh water.

2.1.2 IS-5120 : Technical requirements - Rotodynamic special purpose pump.

2.1.3 IS-1710 : Vertical turbine pumps for clear, cold and fresh water.

2.1.4 BS - 599 : Method of testing Pumps.

2.1.5 PTC - '6' : Centrifugal Pumps Power test code

2.1.6 API - 610

2.1.7 Hydraulic Institute Standards of USA

Wherever standards for certain aspects materials etc., not mentioned, the same shall be as per the applicable Indian or International standards.

2.2 In case of any conflict between the above codes/standards and this specification, the later shall prevail and in case of any further conflict in this matter, the decision of Purchaser's engineering shall be final and binding.

3. DESIGN REQUIREMENTS

3.1 The pumps shall be of heavy duty suitable for long periods of uninterrupted service and shall be standard product of the manufacturer thoroughly proven for satisfactory performance and reliability.

3.2 The materials of construction of various components shall be as indicated under Data Sheet-A and where not specified to the applicable Indian/British/American standards..

3.3 All pressure containing components including the pump casing, nozzles and stuffing box housing shall be designed, fabricated and tested in accordance with applicable Indian standards if not specified otherwise.

3.4 The pump shall be suitable for handling the fluid as specified in Data Sheet-A.

4. CONSTRUCTION FEATURES:

4.1 **PUMP CASING**

4.1.1 Pump casing may be axially or radially split or barrel type construction as specified in the pump data specification sheet. The casing shall be designed to withstand 1.5 times the maximum pressure developed by the pump at the pumping temperature.

4.1.2 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self venting & priming. Casing drain, as required, shall be provided complete with drain valves or plugged with threaded plugs as required.

4.1.3 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

4.1.4 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610

4.2 **IMPELLER**

4.2.1 Unless specifically indicated under Data Sheet-A enclosed, the pump impellers shall be of closed vane type. The impellers shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. Impellers shall be checked for eccentricity and statically and dynamically balanced individually. The assembled rotor shall be dynamically balanced and checked for eccentricity. Supplier shall ensure during balancing that wall thickness of impeller vane, shroud etc is maintained above the minimum thickness requirement as per design.

4.3 **WEARING RING**

4.3.1 Renewable wearing rings for the casing and/or the impellers and renewable shaft sleeves, shall be provided for all pumps. Length of the shaft sleeves must extend

beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

4.4 **SHAFT**

4.4.1 Shaft size selected shall take into consideration the critical speed which shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runway speed.

4.5 **BEARING**

4.5.1 Bearings and hydraulic devices**,** of approved make, (if provided for balancing axial thrust) of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its Range of Operation and also at the shut off condition. The bearing shall be designed on the basis of 20,000 working hrs minimum for the load corresponding to the duty point. Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid being pumped. Where there is a possibility of liquid entering the bearing, suitable arrangement in the form of deflectors or otherwise shall be provided ahead of bearing assembly. Bearings shall be easily accessible without disturbing the pump assembly.

4.6 **STUFFING BOX**

4.6.1 Packed type stuffing boxes of adequate depth with lantern rings shall be provided to minimize the leakage. In all cases where the pump suction is below atmospheric pressure, the shaft packing shall be sealed by the liquid pumped by tapping off from the pump discharge itself and all pipes, valves, fittings etc., required for this shall be furnished by the manufacturer. Tubings used for connections shall be flexible metallic type preferably SS-304/316. PVC/ rubber tubings are not acceptable.

4.7 **SHAFT COUPLING**

4.7.1 The pumps shall be directly coupled to their drives through heavy-duty flexible coupling. Suitable sturdy coupling guards of min. 1.5 mm MS sheet/ Aluminium sheet shall be provided along with the coupling. The pump and its drive motor shall be mounted on a common base plate.

4.8 **BASE PLATE AND SOLE PLATE**

4.8.1 Unless otherwise stated the data specification sheet, a common base plate mounting both for the pump and drive shall be furnished. The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust, etc. Suitable drain taps and drip lip shall be provided. The external corners of the base plate shall be rounded to avoid sharp corners. Drilled holes shall have sufficient space around for proper seating of washer with nut. If required in the data specification sheet, steel sole plates shall be provided, below the base plate.

4.9 **PRIME MOVER**

4.9.1 The drive motor selected shall conform to the requirements of the enclosed motor specifications.

4.10 **LIFTING ARRANGEMENT**

4.10.1 Each pump and motor shall incorporate suitable lifting attachments e.g. lifting lugs or eye bolts etc., to facilitate erection and maintenance..

5. PERFORMANCE REQUIREMENTS

5.1 The pump shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the Range of Operation as stipulated in the data specification sheets.

5.2 Pump shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off. Power capacity characteristic will be non-overloading type i.e. 110% of the design flow the power required to drive the pump will be practically the same as that at the design flow.

5.3 Wherever specified in data sheet, pumps of each category shall be suitable for parallel operation. The head vs capacity, input power vs. capacity characteristics, etc., shall match to ensure equal load sharing and trouble free operation throughout the range.

5.4 The pump motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any malfunction of the system.

6. DRIVE RATING

6.1 The power rating of the drive shall be selected such that a minimum margin of 15% is available over the pump input power required at the rated duty point. However, the drive rating shall not be less than the maximum power requirement at any point within the 'Range of Operation' specified.

6.2 In cases where parallel operation of the pumps are specified the actual drive rating is to be selected by the bidder considering overloading of the pumps in the event of tripping of one of the operating pumps.

6.3 The bidder under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.

7. SCOPE OF INSPECTION AND TESTING

7.1 **CASTING**

7.1.1 The Witnessing pouring and thereafter physical testing of castings of 'Critical' nature such as casings, impellers, diffusers. Castings shall have 'as cast' heat numbers

unless they require overall machining. For partially machined components manufacturer shall ensure availability of as cast heat nos. on unmachined area.

7.1.2 Identification and correlation with test reports for all tests as per the relevant material specifications for castings of 'Major' nature such as suction bell, discharge elbow, stuffing box, gland, wearing rings, shaft sleeves etc.

7.1.3 Foundry's conformity certificate for castings of 'Minor' nature such as base plates, covers etc.

7.1.4 Verification of Heat treatment charts (as applicable)

7.1.5 Castings may be required to meet NDT requirements such as Radiography, Magnetic Particle Testing or Dye-penetrant testing prior to Hydro-test as per requirements specified in Quality Plan.

7.1.6 Surface finish of Steel castings shall meet MSS SP-55.

7.2 **FORGING**

7.2.1 Identification and correlation with mill test certificates for all tests as per the relevant specifications for important forgings like casings, stage bodies, diffusers, shaft material.

7.2.2 Verification of heat treatment charts (time temperature) (as applicable).

7.2.3 Forgings may be required to meet NDT requirements such as Radiography, Magnetic Particle Testing or Dye-penetrant testing prior to Hydro-test as per requirements specified in Quality Plan.

7.3 **FABRICATED ITEMS**

7.3.1 Identification and correlation with mill test certificates for material of items such as discharge bellows, column pipes etc.

7.3.2 Approval of welding procedure specifications and qualifications of weld procedures and personnel as per ASME Sec IX.

7.3.3 Dye penetrant tests of weldment as per ASTM E-165 and acceptance norm as per ASME Sec.VIII, Div.1, Appendix 8

7.3.4 Verification of heat treatment charts (time temperature), (as applicable)

7.3.5 **Note:** For para 7.1.2, 7.2.1 and 7.3.1 above; in case correlating original test certificates are not available, material shall be identified by Main Vendor and test conducted at NABL approved Laboratory.

7.4 **IN PROCESS INSPECTION AND TESTING**

7.4.1 Identification Dye penetrant testing after machining for impellers including vanes, pump shaft, diffusers as per applicable code; in absence of which, as per ASTM E - 165. Permissible defects and acceptance norms need to be specified. On static parts acceptance norms are as per ASME Sec.III NB 2546.

7.4.2 Ultrasonic testing of dynamic duty component, i.e. pump shafts (50mm dia and above) and static duty forgings i.e. Barrel, casting (15mm and above wall thickness)

as per applicable code, in absence of which as per ASTM E388 and acceptance norms as stipulated hereunder. Probe shall be of min. 2 MHz frequency.

7.4.3 Acceptance norms for UT for dynamic duty components. the following defects are unacceptable

a) Cracks, flakes, seams and laps

b) Defects giving indications longer than that from a 4mm equivalent flaw.

c) Group of defects with maximum indications less than that from a 4mm equivalent flaw, which cannot be separated at testing sensitivity, if the back echo is reduced to less than 50%.

d) Defects giving indications of 2 to 4mm dia. equivalent flaw separated by distance less than four times the size of the larger of the adjacent flaw.

7.4.4 For static duty components - as per NB 2542.2 of ASME Sec. III

7.4.5 Hydro tests of all pressure parts such as casings, column pipes, discharge elbows etc., at two times duty point pressure or 1.5 time shut off pressure, whichever is higher for 30 min., without any leakage.

Note : In case the pump is required to boost certain pressure, the inlet pressure head shall also be taken into consideration to compute test pressures

7.4.6 Static and dynamic balancing of individual impellers and also assembled rotors as per V.D.I. 2060 Q 6.3 or ISO 1940 G 6.3.

7.5 **PERFORMANCE TEST**

7.5.1 Pump testing with unit supply motor as per specifications and acceptance norms cited elsewhere, in absence of which as per IS 5120 latest edition. Performance shall be checked for minimum of 7 points (including shut off head and over load) following characteristics shall be checked.

a) Capacity V/s Head

b) Capacity V/s Power absorbed by pump

c) Capacity V/s pump efficiency

Note : For pump of fire protection system, performance test shall be conducted up to 150% of rated capacity.

7.5.2 NPSH test in case specifically mentioned elsewhere.

7.5.3 Vibration, noise level and temperature rise measurement. Noise level shall be within 85dB(A) at 1 metre distance. Vibration within satisfactory zone of VDI 2056 Group G machines. Temperature shall not exceed ambient + 40 deg. C.

7.5.4 Overall dimensions as per GA drawings. One pump/type/size assembly with job motor shall be mounted on base plate, provided the components are ordered on the same manufacturer.

7.5.5 Examination after selective opening up after running for pumps operating at speed over 1800 rpm and capacity exceeding 68M3/hr.

7.5.6 Painting and packing as per technical specification.

7.6 **TEST AT SITE**

7.6.1 The pumps will be tested at site by the purchaser to verify their performance. If the pumps fail to operate smoothly or within the required performance all such deficiencies shall be rectified by the manufacturer by making suitable alternatives in the pump set and additional tests required to show the effect of such alterations shall be performed by him.

7.7 **PERFORMANCE GUARANTEE**

7.7.1 The vendor shall guarantee the material and workmanship of all components as well as the operation of the pump as per requirement of this specification. The vendor shall also guarantee for each pump the total dynamic head at the specified rated capacity and also corresponding efficiency, brake horse power and shut off head

8. CLEANING, PROTECTION , PAINTING & PACKING

8.1 Before shipment of the equipment to be supplied under this specification the necessary cleaning, flushing etc., as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere shall be done to remove all dirts, scales etc. Shop coats of rust inhibiting paints, lacquers etc., shall be applied to various parts as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere. Flanges, inlet and outlet pipe, etc shall be protected. Packing shall be done as per manufacturers standard/ as specified for the contract in Data Sheet A/ elsewhere.

9. DRAWINGS, TECHNICAL DOCUMENTS AND OTHER INFORMATION REQUIRED WITH THE PROPOSAL

9.1 Fully dimensioned outline GA drawings of the pump motor assembly unit for each type and size offered. This drawing should include:

a) Foundation base plate and sole plate details as applicable

b) Civil foundation and anchor bolts details and loading data

c) Minimum submergence required for the pump (if applicable)

9.2 Cross sectional drawing of the equipment showing the details of assembly of components and their material of construction and/ make with standard applicable codes.

9.3 Performance characteristics (Discharge capacity vs head, BHP and efficiency of the pumps.

9.4 Motor speed torque curve superimposed on pump speed torque curve. Required NPSH of pump.

9.5 Experience list about the supply and successful operation of similar pumps for similar application.

9.6 A comprehensive write up or brochure on the details of manufacturing and testing facilities in the shop of the manufacturer.

9.7 Quality plan for the equipment being offered, in BHEL format as practiced in the manufacturer's works and Field Quality Plan for receipt, storage erection, commissioning & testing at site.

9.8 Data sheet-B with all the particulars filled in.

10. MANUFACTURERS NAME AND TAG. PLATES

10.1 Each pump shall have a permanently attached brass/ Stainless steel tag on the body indicating the following information both in Hindi and English:

a) Manufacturer's name and trade mark.

b) Design Capacity and Head.

c) Design.

d) Purchaser's tag no. as furnished during the contract. The purchaser's tag no. will be indicated by the Purchaser on the drawing submitted for approval by the vendor.

11. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

11.1 Certified GA drawings of pump motor assembly weights, crane.

11.2 Detailed cross sectional drawings of the pump and motor assembly and all equipment & accessories supplied under the this specification along with details of material of construction with applicable standard codes.

11.3 Foundation drawings with details of foundation pocket indicating static as well as dynamic load and other data with dimensions.

11.4 Certified characteristics curves (discharge capacity vs. head, BHP and efficiency) of each type of pump and motor.

11.5 Material and other test certificates as required by the application clauses of this specification.

11.6 Motor speed torque curves super imposed on pump speed torque curves.

11.7 Quality plan along with complete details of testing and inspection requirements of centrifugal pumps in BHEL format. Vendor shall also furnish Field Quality Plan.

11.8 Installation , operation and maintenance manual.

11.9 Other drawings and data, if necessary.

DESCRIPTION		DATA
1.	Designation	: Condenser water and Chilled Water pumps for AC plant.
2.	Type	: Horizontal, Centrifugal pump or vertical split type casing pump .
3.	Quantity	: Refer to section-C of Specific Technical Requirements
4.	Installation	: On floating type foundation.
5.	Fluid to be handled	: Water
6.	Temperature of fluid	: To suit.
7.	Capacity M3/hr and TDH at rated	: To suit system requirements but head shall not be less than 25 MWC.
8.	Duty	: Continuous (24 hours / day)
9.	Suction condition	: Flooded
10.	Type of drive	: Direct
11.	Prime Mover	: LV AC motor
12.	Maximum speed	: 1500 RPM
13.	Type of lubrication	: Grease Lubrication
14.	Material	
	a) Impeller	: Bronze to Grade IS: 318 Grade 2
	b) Pump shaft	: EN - 8 / Equivalent (Approved).
	c) Casing	: CAST IRON TO IS: 210 Grade - 260.
	d) Wearing ring	: Bronze to Grade IS:318 GR-2, Renewable type.
	e) Shaft Sleeve	: -do-
	f) Base plate	: Cast Iron to Grade FG-200 IS-210/M.S. fabricated.
	g) Bolt and nuts.	: MS
	h) Stuffing Box gland/bush case.	: Deep Bronze packing to be renewable with

i) Stuffing box Packing. : Flexible Graphite or PTFE (Asbestos shall not be used)

j) Pump motor coupling. : Flexible.

15. **ACCESSORIES REQUIRED:-**

The following accessories shall be provided by the bidder for each pump:

a) Suction & Discharge pressure gauges. : Yes.

b) Vent connection : Yes.

c) Drain piping up to common drain point in plant room. : Yes

d) Companion flanges. : Yes

e) Common base plate. : Yes.

f) Suction strainer. : Yes

g) Isolating valve : Yes

h) NRV at pump outlet at inlet/outlet : Yes

i) Any special requirements : The Chilled Water pumps shall be suitably insulated as per spec.

j) Inspection & Testing : As per specification enclosed elsewhere.

STANDARD TECHNICAL SPECIFICATION FOR PACKAGE CONDITIONING UNIT

1 GENERAL

1.1 This specification covers the design, manufacture, inspection and testing at the manufacturer's works and suitable packing delivery and testing of the packaged air conditioning unit.

2 CODES AND STANDARDS

2.1 The design, manufacture, inspection, testing and performance of the packaged type air conditioning unit shall comply with all statutes, regulations and safety codes currently applicable in the locality where the equipment will be installed. The equipment shall also conform to the latest editions of the codes and standards specified herein under. Nothing in this specification shall be construed to relieve the vendor of this responsibility.

In particular, the packaged air conditioning Unit (max 7.5 TR capacity, ductable or non ductable type) or cassette type (up to 5 TR) shall conform to the latest editions of the following standards:

2.1.1 I.S.660 : Safety code for Mechanical Refrigeration.

2.1.2 I.S.5111 : Code of practice for measurement, and testing of refrigerant compressor.

2.1.3 I.S.659 : Safety code for air conditioning.

2.1.4 I.S.2494 : V Belt for industrial purpose.

2.1.5 I.S.3142 : V grooved pullies for V Belts.

2.1.6 I.S.4503 : Shell and tube type heat exchanger.

2.1.7 ARI 210 : Standard for/unitary air conditioning equipment

2.1.8 ARI 270 : Standard for application installation and servicing of unitary equipment.

2.1.9 ASHRAE-37 : Standard methods of testing for rating unitary air conditioning and heat pump / equipment.

2.1.10 ANSI-B9-1 : Safety code for mechanical refrigeration.

3 DESIGN AND CONSTRUCTIONAL REQUIREMENTS

3.1 Compressor

The compressor shall be hermatic or semi-hermatic or screw rotary type or scroll type. The same shall be suitable for R410A/R407C/R134A refrigerant. The compressor shall be mounted on anti-vibration spring/rubber pads and shall be positioned in such a way that it is freely accessable with sufficient space all around for easy maintenance. Safety controls like High and Low pressure cut-out overload and single phasing protection for the motors shall be provided. A crankcase heater shall also be provided, if considered necessary by the vendor.

3.2 **CONDENSING UNIT**

Shell and tube type water cooled condenser or air cooled condenser with adequate area shall be provided as specified in Data Sheet-A. The condensing unit shall be complete with

multipass heads and shall be fitted with the following:

3.2.1 Hot gas inlet and liquid outlet connection with shut off valve for liquid.

3.2.2 Drain plug, air vent and test valve.

3.2.3 Water inlet and outlet connection with thermowell and suitable cocks respectively.

3.2.4 Relief valve and air purge valve (Fusible plug in place of relief valve not acceptable)

3.2.5 Any other accessory as recommended by the manufacturer for proper functioning of the equipment.

3.3 **AIR HANDLING FAN**

The air handling fan shall be of the centrifugal type and with forward curved blades. This shall be driven by means of a three phase induction motor through V belt drive. The fan static pressure shall be selected for passing air through high efficiency absolute filters, if specified in Data Sheet-A.

3.4 **FILTERS**

Filters shall be of dry panel type and shall be cleanable. The velocity of air across the filters shall not exceed 1.75m/sec (350FPM).

3.5 **COOLING COIL**

The cooling coil shall be of direct expansion type and shall be made of heavy gauge copper with aluminium fins. The fins shall be bonded to the copper tubes under hydraulic pressure. A distributor shall be provided for feeding the refrigerant to different sections of the coil. Rows shall be staggered in the directions of airflow. The velocity of air across coil shall not exceed 2.5M/Sec. (500 FPM).

3.6 **CONTROLS**

All necessary controls and accessories like thermostatic expansion valve, refrigerant solenoid valve, distributor, filter drier in the liquid lines, shut off valves, HP/LP cut out for compressor, thermostat with adjustable settings, overload and single phasing preventer for motor etc. are to be provided. The microprocessor based control panel shall be provided outside the packaged unit on one side. The control panel shall generally be in line with the specification for control panels given elsewhere.

The control shall be so interlocked that the fan shall be started independently first, and then only the compressor. Tripping of the compressor by the thermostat or compressor cut outs shall not trip the fan. The thermostat setting shall be adjustable

3.7 **REFRIGERANT PIPING**

The refrigerant piping shall be either heavy gauge copper as furnished in Data Sheet-A. The piping shall be completely factory assembled, pressure tested, dehydrated and initially charged with FREON gas and compressor oil. The line accessories shall include liquid line shutoff valve dehydrator, strainer, flow indicator and distributor etc.

3.8 **CABINET**

All the equipments, except control panel, mentioned above shall be provided within a heavy gauge sheet metal cabinet, of floor/ wall mounted type. This shall be given two coats of anti-corrosive and rust proof paint, finished with two coats of final paint . Painting shall be as per manufacturers std unless specified otherwise in data sheet 'A'. The interior of the cabinet shall be provided with thermal and acoustic insulation of minimum 25mm thick. The insulating material shall be fire proof.

The front and back side of the cabinets shall be easily removable providing maintenance to all the interior parts.

All the electric wires within the cabinet shall run in flexible conduits and carry identification tags. The bottom side of the panel shall be specially ribbed to take care of the transportation.

3.9 **OTHER ACCESSORIES**

Each packaged air conditioner shall be provided with required number of neoprene rubber isolating pads.

4 CONTROL AND INTERLOCK REQUIREMENTS

The compressor shall have all protective devices like HP/LP cutouts, overload protection for the motor, single phasing preventor for motor etc.

The interlocking requirement shall be as indicated below:

4.1 The compressor shall not start, unless condenser water flow is achieved for water cooled condenser. The condenser flow shall be sensed by means of a flow switch.

4.2 The compressor shall not start unless the evaporator fan is started.

4.3 The tripping of compressor on HP/LP, overload or on thermostat shall not trip the fan.

4.4 Strip heater (if provided in the ducting system) shall not be switched on, unless the evaporator fan is started and airflow is established. For this purpose, an air stat on flow switch shall be used. The heater shall be separately controlled by humidistat/thermostat

4.5 A humidifying package, if specified in data sheet A, shall be controlled by humidistat.

5 TEST AND INPSECTION

5.1 Inspection and Testing at Manufacturer's Works

5.1.1 static and dynamic test for fans

5.1.2 Hydrostatic static test on condenser and cooling coil.

5.1.3 vacuum/pressure test for the complete refrigeration circuit.

5.1.4 Visual and Free running test of the packaged unit on test bed.

5.1.5 Free running test on compressor.

5.1.6 AIR CAPACITY WITH ANEMOMETER.

5.1.7 NOISE LEVEL- <=85 dB(A).

5.1.8 Other tests as per approved qualities plan/scope of inspection.

5.2 Inspection and Testing at Site

5.2.1 Performance testing of the packaged unit for 72 hours in summer / monsoon & 24 hours in winter. Up-to 3 TR (individual M/c capacity) inside room temperature (Dry & wet bulb) will be checked with all machines in the room operating.

The actual days of testing shall be mutually agreed. During the above testing, the following readings shall be taken to compare the same with guaranteed performance data.

5.2.1.1 Condenser inlet and outlet pressure and temperature

5.2.1.2 Entering and leaving air temperature of the cooling coil air filters.

5.2.1.3 Motor current for the compressor and blower.

5.2.1.4 Air quantity delivered by the fan. This shall be computed by adding air quantity leaving all the grilles entering the air filters.

Room temperature (Dry & wet bulb)

5.2.1.5 Test to ensure all controls and safety instruments are working properly.

During the above testing, noise level also will be checked to ensure that the same are within acceptable limits. Any undue vibration detected physically will be corrected.

All tools and instruments required for the above testing will be provided by the vendor.

6 PAINTING:

The packaged unit shall be given two coats of primer paint finished with two coats of finish paint as per Manufacturers std. unless specified otherwise elsewhere/ Data sheet 'A'. The colour of finish paint will be as specified in Data Sheet-A.

7 GUARANTEES

The package unit shall be guaranteed for performance measured in terms of the inside temperature maintained.

The packaged unit shall also be free from any manufacturing defects and shall be guaranteed as per contract after the first test as per 5.0 is successfully carried out, and the plant taken over by the purchaser.

8 NAME PLATES

Suitable Name plate as per Data Sheet 'A', depicting the equipment number as designated in Data Sheet A shall be provided for each packaged unit and screwed to a prominent position on the packaged unit.

9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1 Final technical data as per Data Sheet-B

9.2 G.A. and interior view of packaged unit

9.3 Electrical wiring diagram

9.4 Catalogues for all controls

9.5 O & M Manual

9.6 Erection Manual

	DESCRIPTION	DATA
1)	Capacity of the unit at operating conditions.	: As specified
2)	Numbers required	: Refer to Section-C of Specific Technical Requirements
3)	Designation of the unit	: Package AC Unit
4)	Whether air cooled/water cooled	: Refer to Section-C of Specific Technical Requirements
5)	The plant shall be suitable for maximum- - ambient temp.	: Refer outdoor design condition as specified.
6)	Whether a plenum Chamber required	: Units shall be connected to fresh air ducts.
	OR	
	Whether to be connected duct system.	: Yes.
7)	Whether Humidifier required for humidity- -control.	: Refer to Section-C of Specific Technical Requirements
8)	Whether strip heaters required for winter heating.	: Refer to Section-C of Specific Technical Requirements
9)	Whether strip heater required for Humidity control.	: Refer to Section-C of Specific Technical Requirements
10)	Final painting colour shade stage.	: Subject to approval / during detail engineering
11)	Whether fan static pressure is to be designed for filters arrangement shown.	: Yes.
12)	Installation supporting structure/ drain piping, insulation.	: Required. Drain piping with insulation up to the nearest drain point.
13)	Controls & Instruments	: Yes (Lot)
14)	Isolation Switch	: Yes

STANDARD TECHNICAL SPECIFICATION FOR AIR FILTER

1. GENERAL

This specification covers the design, manufacture, inspection and testing at manufacturer's work or his sub-contractor's works of Air filters to be used for air-conditioning and ventilation system.

2. CODES AND STANDARDS

This design, manufacture and performance of AIR FILTERS shall comply with all currently applicable statutes, regulation and safety codes in the locality where the equipment will be installed. The equipment shall also conform to latest applicable Indian/British/USA standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. The following standards, in particular, shall be applicable for certified ratings of filters and for conducting performance test, if required.

a) BS EN - 779 -Methods of test for air filters used in air conditioning and general ventilation.

3. GENERAL

The enclosed Data sheet A gives the type and other particulars of filters required.

3.1 POLY FIBRE AIR FILTERS

Filtering media shall consist of a suitable fibrous material (e.g. polyethylene extruded sections coir etc.) packed into a 20 gauges GSS framework, complete with handles etc. The filter element shall be supported by galvanised steel wire mesh of 10mm. sq. on either side, Velocity across the filters shall not exceed 2.5 M/sec. Average efficiency Em (%) shall be >/= 80 as per BS EN - 779.

3.2 DRY FABRIC AIR FILTERS

Filter element shall be pressed felt filter fabric or suitable material recommended by the manufacturer, stitched on to galvanised wire gauge support and crimped to form deep folds. Suitable aluminium spacers shall be provided to ensure uniform distribution of air flow through filters. Filter casing shall be provided with neoprene sponge rubber sealing, The filter shall have Average efficiency Em (%) of >/= 95 as per BS EN - 779.

3.3 PANEL TYPE METALLIC FILTERS (DRY/VISCOUS)

Filter shall consist of V-fold galvanised wire mesh interspaced with flat layers of galvanised wire mesh. The density of media shall increase in the direction of air flow. Edges of wire mesh shall be suitably hemmed to prevent abrasion during handling. The media shall be supported on either side by galvanised expanded metal casing. The framework shall be at least 18 gauge GSS. Filter shall be either dry or wetted type as per data sheet=A. The oil shall be mineral oil of approved quality and make. As a the filter frame made of Aluminium alloy conforming to IS:737 can be considered unless use of aluminium is prohibited otherwise due to site conditions being saline/corrosive.

All filters shall be capable of being cleaned of their accumulated dust by tap water flushing. The dry metallic filter shall have Average arrestance Am (%) shall be >/= 90.

However oil wetted air filters shall have Average Efficiency Em (%) >/= 90 as per BS EN - 779..

3.4 AUTOMATIC CLEANING FILTERS

This shall consist of a filter mat and drop eliminator, driven by a suitably rated geared motor unit being supported on a steel framework. The filter mat shall consist of an endless steel wire mat insets of steel mesh held between an upper & a lower shall drop eliminator shall consist of an endles steel wire without insets of steel mesh. The unit shall include a suitable oil pump, gladge raking mechanism and sludge container and tensioning device. Pressure drop shall be limited to 0.5 / mm WG when clean & 10 mm when dirty. Air velocity across filter shall not exceed 3 M/sec.

3.5 ABSOLUTE FILTERS

Filters shall be constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by heavy corrugated aluminium spacers. They shall be individually tested and certified to have an efficiency of not less than 99.97% when tested with 0.3 micron dioctyphalate smoke as per IS:2831. The clean filter initial static pressure drop shall not be greater than 25mm WC at rated capacity. A neoprene sponge rubber sealing shall be provided on either face of filter frame.

3.6 WATER REPELLANT NYLON FILTERS

This shall be constructed of water repellent nylon fabric with continuous water spraying on it from a header for keeping it clean. Efficiency of this filter shall be 85% down to 10 microns. This filter shall be used for unitary air filtration system only.

4. INSPECTION & TESTING

The scope of inspection for air filters shall be as below:

4.1 Dimensional inspection of frame & filter media.

4.2 Witnessing of type tests on one per type per size air filters for the following properties.

a) Gravimetric efficiency.

b) Pressure drop in clean & dirty (choked - %age to be specified) condition.

c) Efficiency as per BS EN - 779.

4.3 Verification of type test certificates for similar type & size of filters for sodium flame test as per BS-3928 (if applicable- refer data sheet).

5. DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

5.1 GA Drawing.

5.2 Drawing showing material/construction detail

5.3 Installation and\service manual

5.4 Rating curves/charts

5.5 Test certificates

5.6 Elect. diagrams (when automatic cleaning type)

DESCRIPTION		DATA
1)	**General**	
1.1	Service	: Air Conditioning.
1.2	Location	: Central Air conditioning plant, & package AC plant, fresh air fan system. Also for split AC.
1.3	Nos.	: Refer Section 'C' of Specification.
1.4	Total air flow/type	: Refer Section 'C' of Specification.
1.5	Temperature	: As per project information.
1.6	Relative Humidity	: 100%
1.7	Gas Composition	: Atmospheric Air (Dusty) as prevalent in power Station.
1.8	Filter Media	: Synthetic non-woven
1.9	Efficiency	: Average arrestance efficiency of 65-80 % for Dry Panel filter (pre-filters) and average arrestance Efficiency of 80-90 % for fine filters.
1.10	Allowable pressue drop	: 2.5 mm & 6.5 mm in clean and dirty condition respectively for dry panel filters(prefilters). 12 mm in clean condition for fine filters.
1.11	Frame Work	: 18 G, GSS.
1.12	Mounting	: Ladder Type M.S Angles (galvanised)
1.13	Size	: 600 x 600 mm

Note:-

1) Face velocity of air across the filters shall not exceed 2.5 m/sec.

STANDARD TECHNICAL SPECIFICATION FOR THERMAL INSULATION FOR COLD SURFACES

1. SCOPE

This specification covers design, manufacture, testing at manufacturers works, supply, application & finishing of insulation for cold piping, air conditioning ducting & equipment for low temperature service.

2. CODES & STANDARDS

The design, manufacture and performance of materials covered under this specification shall comply with all currently applicable statues, regulations & safety codes in the locality where the equipment/material are to be installed. The material shall also conform to the latest applicable Indian/British/American codes & standards. Nothing in this specification shall be construed to relieve the vendor of his responsibility. In particular, the material shall conform to the latest editions of the following standards :-

IS:3069: GLOSSARY OF TERMS & SYMBOLS & UNITS RELATING TO THERMAL INSULATION

materials.

2.1 IS:4671: Expanded polystyrene for thermal insulation purposes.

2.2 IS:3677: Mineral wool for thermal insulation.

2.3 IS:8183: Resin bonded mineral wool.

3. DESIGN REQUIREMENTS

3.1 The insulating material as well as protective covering shall be new & unused, non-corrosive, vermin/rodent proof and shall be guaranteed to withstand continuously & without deterioration the maximum/minimum temperatures to which they may be subjected to, under specified site conditions.

3.2 The insulation material must be light weight, strong, free from shots & coarse fibre & shall provide high insulation efficiency at low weight & coat. It should be non-hygroscopic & should not rot. It shall not settle or shake down even when subjected to prolonged vibrations.

3.3 The insulation material, density and thickness etc. Shall be as specified in DATA SHEET A.

4. APPLICATION DETAILS

4.1 The surface to be insulated shall be thoroughly cleaned and allowed to dry. Pressure/hydrostatic tests, if any, shall be carried out before application of insulation.

4.2 A layer of solvent free, anticorrosive paint shall be applied & allowed to dry.

4.3 Hot industrial bitumen of grade 85/40 or 85/25 conforming to latest IS:702 shall be uniformly applied @ 1.5 kg/sq.m on the surface to be insulated. A similar layer shall also be applied on the inside surface & edges of the insulation. A suitable cold adhesive compound may also be used in place of bitumen.

4.4 Insulation in the form of pipe sections/rolls slabs of specified density & thickness shall be stuck to the coated surface with joints staggered & well butted & secured. The adjoining sections shall be tightly pressed together. All the joints shall be sealed with

bitumen/equivalent adhesive. Voids if any shall be packed with suitably cut pieces of insulation material.

4.5 In case of double layer application both circumferential & longitudinal joints shall be suitably staggered.

5. VAPOR SEALING & INSULATION FINISH

The insulation shall be treated for vapor sealing & weather proofing & finished as specified in DATA SHEET A The acceptable types of finishes are outlined below:-

5.1 FINISHING SYSTEM I: EXTERNAL INSULATION WITH PLASTER FINISH

5.1.1 A thick vapor seal of hot bitumen @ 2.5 kg/Sqm shall be applied on the outer surface of insulation & allowed to dry.

5.1.2 The surface shall then be wrapped with 20mm (3/4"_ hexagonal mesh of 24 SWG GI wire, butting all the joints & laced down with 22 SWG GI lacing wire.

5.1.3 12.5mm (1/2 inch) thick sand cement plaster in the ratio of (1:1) shall be applied in two layers, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.

5.2 FINISH SYSTEM II: EXTERNAL INSULATION WITH PLASTER FINISH OVER POLYTHENE.

5.2.1 The insulation shall be covered with 500 g polythene/polythene bonded Hessians (PBH) with 50mm overlap on longitudinal & circumferential joints. Overlaps shall be sealed with synthetic adhesive in case o-f polythene & liberal coat of bitumen in case of PBH:

5.2.2 The surface shall then be wrapped with 20mm (3/4") mesh of 24 SWG GI wire butting all the joints & laced down with 22 SWG GI lacing wire.

5.2.3 12.5mm thick (1/2 inch) sand cement plaster in ratio of(4:1) shall be applied in two layers, the second layer being brought to a smooth & even finish similarly as described above.

5.3 FINISH III:EXTERNAL INSULATION WITH SHEET METAL FINISH

5.3.1 The insulation shall be covered with 500g polythene with 50mm overlaps at joints which shall be sealed with synthetic adhesive or equivalent compound.

5.3.2 The polythene shall be covered with 24 gauge GI/aluminum sheet

5.3.3 25mm wide x 22 SWG GI/aluminum peripheral straps shall be fixed over the GI/aluminum sheet at 300mm centres to secure.

5.4 FINISH IV: EXTERNAL INSULATION WITH PLASTER & WATER PROOFING COMPOUND

For ducts & piping exposed to atmosphere, the finish shall be as follows:

5.4.1 A thick vapor seal of hot bitumen at 2.05 kg/sq.m shall be applied on the outer surface of insulation & allowed to dry.

5.4.2 The surface shall then be wrapped with 20mm (32/4") hexagonal mesh of 24 SWG GI Wire butting all the joints & laced down with 223 SWG GI lacing wire.

5.4.3 12.5mm thick (1/*2 inch) sand cement plaster in ratio of (4:1) shall be applied in two layers, the second layer being brought to a smooth finish with water proofing compound added to the cement.

5.4.4 3 mm (1/8") thick coat of water proofing compound shall be applied & wrapped with fibre glass RP tissue. A final coat of 3mm thick water proofing compound shall then be applied over the fiberglass RP tissue & allowed to dry. Alternatively, in place of water proofing as desired above, tar felt type 3 grade 1 of IS 1322 with joints overlapped by 75mm shall be fixed & sealed with bitumen & over this 24 SWG. 25mm hexagonal GI mesh shall be fixed with 22 swig. GI lacing wire & finally bitumen paint shall be applied over wire netting.

6. INSULATION OF PUMPS & VALVES

6.1 For all inspection covers & hatches on equipment, pump casing & valve bodies, flanges etc. the insulation shall be applied such as to facilitate removal with minimum damage to the insulation. This shall be achieved by encasing the insulation in 22 gauge aluminum sheet metal boxes, which shall be bolted together around the equipment to permit easy removal & replacement. Proper care shall be taken to maintain continuity of vapor seal between the static & removable partitions of the insulation.

6.2 The tenderer may offer thickness of insulation & finishes other than that specified in DATA SHEET A. However, calculations/reasons in support of alternative proposal shall be furnished for purchaser's approval.

7. INSPECTION & TESTING (REFER SPEC. NO - PES-553.00)

7.1 All necessary tests, as required to ensure that the material supplied conform to the requirements of applicable codes & standards, shall be carried out at manufacturer's works & test certificates including these for material/accessories shall be furnished for purchasers approval.

8. PAINTING

8.1 Pipe work having insulation & cladding shall be provided with color identification for the fluids handled and for indicating direction of flow.

8.2 Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

8.3 All painting for insulated surfaces shall conform to the requirement specified elsewhere.

9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1 Final version of data sheet 'B' incorporating changes if any along with design data.

9.2 Test certificates/reports giving result of insulation to ensure conformance to applicable codes & standards & in particular the following:-

a) Thermal conductivity test.

b) Sound absorption coefficient test.

c) Corrosion test.

d) Sulphur content, moisture content, shot content, moisture absorption etc.

e) Compressive strength & cross breaking strength test.

9.3 Sketches/technical literature/sectional drgs. indicating insulation materials finish and method of application etc.

9.4 Manual dealing with safety aspects & instructions for combating fire arising out of insulation work.

9.5 Instructions on maintenance of insulation work**.**

Insulation Material

Insulation	Code	Thermal Conductivity MW/cm ^{0}C	Density Kg/m^3
Resin bonded mineral wool / glass wool	IS:8183	0.49 at 50 ^{0}C	At least 24 for duct insulation and 48 for acoustic lining.
Mineral Wool Pipe Section (min. Gr.2)	IS:9842	0.43 at 50 ^{0}C	At least 81
Expanded Polystyrene	IS:4671	0.37 at 10 ^{0}C	At least 15

Type of Insulation

S.No.	Surface	Insulation Material	Insulation Form	Thickness (mm)
i)	Supply & Return air duct for air-conditioning system	Resin bonded roll Mineral Wool (IS:8183)		25
ii)	Refrigerant Piping	a) Expanded Polystyrene	Pipe Section	75
		or		
		b) Mineral Wool	Pipe Section	75
iii)	AHU drain pipe	a) Expanded Polystyrene	Pipe Section	25
		or		
		b) Mineral Wool	Pipe Section	25
iv)	AHU drain pan coil section and fan section	a) Expanded Polystyrene	Slabs	25
		or		
		b) Mineral Wool	Slabs	25
v)	Chilled water piping, valves & specialties	a) Expanded Polystyrene	Pipe Section	75
		or		
		b) Mineral Wool	Pipe Section	75
vi)	Chiller	a) Expanded Polystyrene	Slabs	100
		or		
		b) Mineral Wool	Slabs	100
vii)	Chilled Water Pumps	a) Expanded Polystyrene	Slabs	50
		or		
		b) Mineral Wool	Slabs	50
viii)	Expansion tank with pipe	a) Expanded Polystyrene	Slabs/Pipe Section	50
		or		
		b) Mineral Wool	Slabs/Pipe Section	50

SECTION-I
SUB SECTION -E

LIST OF MAKES OF SUB-VENDOR ITEMS

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	JOHNSON		
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	BELIMO		
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	RAPID CONTROL		
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	ALC		
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	LIMITORQUE		
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	AUMA		
ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	actuator	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
Air Blowers(twin Lobe)	mechanical	air blower	twin lobe	Everest Blowers Pvt. Ltd.	B-44, Block B, Mayapuri Industrial Area Phase I, New Delhi, Delhi 110064 011 4545 7777	
Air Blowers(twin Lobe)	Mechanical	blower	twin lobe	Swam Pneumatics	C-2,SECTOR-3,NOIDA-201301,(U.P.) INDIA. Telephone: +91-120 - 469 6222 FAX: +91-120 - 244 3282 E-mail: sales@swamatics.com Website: www.swamatics.com	
Air Blowers(twin Lobe)			twin lobe	Kay International Limited	Palla road dahisara villege Sonipat dahisara, Sonipat, Haryana 131028 91-8572899447 Send SMS	
air blowers(twin lobe)	blower	air	twin lobe	KPT LTD	Shirol - 416 103, Dist : Kolhapur, Maharashtra, INDIA. Telephone +91-231-2689900 Fax +91-231-2689946 Website www.kpt.co.in CIN L29130MH1976PLC019147 E-mail support@kpt.co.in	
AIR COOLED CONDENSER	Mechanical	Condenser	Air Colled	Beijing Longyuan Cooling Technology Co., Ltd (BLCT)	No.11 Tongji South Road, Economic & Technological Development Area, Beijing, Beijing Phone- 0086-10-87859981 Pincode : Email : zhaoji@bjlylq.com.cn	
AIR FILTER	Mechanical	Filter	Air	TENACITY		
AIR FILTER	Mechanical	Filter	Air	JOHN FOWLER		
AIR FILTER	Mechanical	Filter	Air	ANFILCO		
AIR FILTER	Mechanical	Filter	Air	PUROMATIC		
AIR FILTER	Mechanical	Filter	Air	SPECTRUM		
AIR FILTER	Mechanical	Filter	Air	AIR TECH		
AIR FILTER	Mechanical	Filter	Air	FMI		
AIR FILTER	Mechanical	Filter	Air	PUROLATOR		
AIR HANDLING UNITS	Mechanical	package	AHU	ZECO		
AIR HANDLING UNITS	Mechanical	package	AHU	CARRYAIRE(FLAKT)		
AIR HANDLING UNITS	Mechanical	package	AHU	BLUE STAR LIMITED	Jamshedji Tata Road, Mumbai - 400 020 Phone: (91) (22) 6665 4000 Fax: (91) (22) 6665 4151 www.bluestarindia.com	
AIR HANDLING UNITS	Mechanical	package	AHU	VOLTAS	Corporate Headquarters Voltas Limited Voltas House 'A' Block Dr. Babasaheb Ambedkar Road Chinchpokli	
AIR HANDLING UNITS	Mechanical	package	AHU	ETHOS		
AIR HANDLING UNITS	Mechanical	package	AHU	WAVES AIRCON		
AIR HANDLING UNITS	Mechanical	package	AHU	SYSTEM AIR		
AIR HANDLING UNITS	Mechanical	package	AHU	EDGETECH		
AIRCONDITIONING SYSTEM	Package			GEMINI SHREEWAS (ENGINEERS) PVT. LTD.	Mr. S. Ramasamy No. 287C, NP, 11th Street Sidco Industrial Estate, Ambattur Chennai Phone- 044-26256011 Pincode : 600 098 Email : contact@geminishreewas.com	
AIRCONDITIONING SYSTEM	Package			VOLTAS LTD.	PUMPS DIVISION, P.O.BOX-72, VOLTAS HOUSE, 19, J.N.HERDIA MARG, BALLARD ESTATE, MUMBAI Phone- 22614715 Pincode : 400038 Email : ljha@voltas.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
AIRCONDITIONING SYSTEM	Package			ADVANCE VENTILATION PVT.LTD.	SUMIT CHAUDHARY, 610, PP Towers, C1,2&3 PP Towers, Netaji Subhash Place, Pitampura, New Delhi, Phone- 0130-2219092-96, Pincode : 110034, Email : sales@advanceventilation.com,	
AIRCONDITIONING SYSTEM	Package			INDUSTRIAL PROJECT & PRODUCTS CO.	Mr. Surinder Singh, Plot No. 61, Block-7 Ward No.1,behind gyandeep school, Near sector-5 Gurgaon Phone- 8510044695 Pincode : 122001 Email : industrialppc.1@gmail.com	
AIRCONDITIONING SYSTEM	Package			STERLING AND WILSON PRIVATE LIMITED	PREMISES NO. GN-31, 2nd & 3rd FLOOR, SECTOR-5, SALT LAKE, KOLKATA-700091, KOLKATA, Phone-9007042713 Pincode : 700091 Email : Swarup.mukherjee@sterlingwilson.com	
AIRCONDITIONING SYSTEM	Package			ROOTS COOLING SYSTEMS PVT. LTD.	Mr. Pradeep Choudhary B-53,HOSIERY COMPLEX, PHASE-II NOIDA Phone- 098109-03848 Pincode : 201305 Email : rcspower@rootsdek.com	
ALUMINIUM SHEETS/COILS	Mechanical			Chongqing Lanren Aluminium Co. Ltd., China	Apev No. 1, Yatai Road, Nanaping Nanan District Chongqing Phone- Pincode : 400060 Email :	
ALUMINIUM SHEETS/COILS	Mechanical			BHARAT ALUMINIUM COMPANY LTD	BALCO Township, P.O. : BALCO Township, Korba Korba Phone- Pincode : 495684 Email : sk.sharma@vedanta.co.in	
ALUMINIUM SHEETS/COILS	Mechanical			JINDAL ALUMINIUM LIMITED	Mr. Abhay Vishwakarma Jindal Nagar, Tumkur Road Bengaluru Phone- 080-23715555 Pincode : 560073 Email : abhay@jindalaluminium.com	
ALUMINIUM SHEETS/COILS	Mechanical			NATIONAL ALUMINIUM COMPANY LTD.	NALCO BHAVAN , P/1, NAYAPALLI BHUBANESWAR Phone- Pincode : 751013 Email : asahluwalia@nalcoindia.co.in	
ALUMINIUM SHEETS/COILS	Mechanical			HINDALCO INDUSTRIES LTD	CENTURY BHAWAN, 3RD FLOOR, DR ANNIE BASANT ROAD, WORLI, MUMBAI Phone-24362516/ 227586 Pincode : 400 025 Email : ashok.jsingh@adityabirla.com	
ANALYSERS ALL TYPE	Electronics	ANALYSERS	ALL	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
Atmospheric storage tanks	mechanical	atmospheric		Progen Systems & Technologies Limited	Add Photo Apollo Computer Education LtdHB EDUCATION AND CONSULTING SERVICES PVT LTDHB EDUCATION AND CONSULTING Triton Square, 1st Floor, Skcl Building, Unit No: C3 To C7, Thiru Vl Ka Industrial Estate, Guindy, C, Guindy, Chennai - 600032 (Map)	
Atmospheric storage tanks	Mechanical	atmospheric		Titan Engineering Company Private Limited	Indrajit Sengupta(Manager) No. 2/7, Sarat Bose Road, 5th Floor ., Sarat Bose Road , Kolkata - 700020, West Bengal, India Call Us: +91-9434009032	
Atmospheric storage tanks	mechanical	atmospheric		Rishi Industries	Address :40 L M Stone,GT Road Sonepat, Bahalgarh Road, Bahalgarh, Sonipat - 131001 , Haryana , India Contact Person :Mr. S D Bhutani (Proprietor) Phone :91-130-2381202 Mobile :+919992555844 State:Haryana Phone:91-1264-282801 Fax:91-1264-282899	
Atmospheric storage tanks	Mechanical	atmospheric		Universal Heat Exchangers Ltd	Plant - I Pollachi Road Malumachampatti Post Coimbatore- 641021, India Phone - +91-(422)-2610835, 2610836 Fax - +91-(422)-2610746 Email - marketing@uniheat.com	
Atmospheric storage tanks	Mechanical	atmospheric		ATS CHEM EQUIPMENTS PVT LTD	Unit - I, C - 27, SIDCO Industrial Estate, Hosur - 635 126, Tamil Nadu, India. Phone : 04344 - 276731 MR. S.THANGARAJ Managing Director Contact No : +91 - 9443378152 Mr. S.Arumugam Director Contact No : Contact No : +91 - 9443376731 Mr. H.M.Ammar Dire	
Atmospheric storage tanks	mechanical	atmospheric		Chem Process Systems	15 Natraj Industrial Estate, Sanand-Viramgam Highway, Vasna-Iyava, Sanand - 382 170. Ahmedabad. India.+91 2717 284148- 49+91 2717 284194 chem@chemprosys.com Mr. Sagar Desai HR Manager sagar@chemprosys.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
Atmospheric storage tanks	mechanical	atmospheric		Crystal Engineering Systems Pvt.Ltd.	Survey No:1186/2A & 2B Opp. to FIEM Industries Kelamangalam road Achettipalli (P.O.), HCF (Via) Hosur-635110. Tamilnadu. India. Phone : 91-4344-656053, 656062 Mobile : +91-9443358771/9655218771 Email : enquiry@crystalengineeringsystems.com A. Jay	
Atmospheric storage tanks	Mechanical	atmospheric		ISHAN EQUIPMENTS PVT. LTD	(UNIT- I) 404 - 405, GIDC Industrial Estate, B/h L&T NIRO, Ranoli - 391 350, Dist Baroda (Gujarat) India +91-0265-2308589 +91-0265-2241217 info@ishanequipments.com	
Atmospheric storage tanks	MECHANICAL	atmospheric	VESSELS	The Anup Engineering Limited	The Anup Engineering Limited Soni ni chali, G I D C Industrial Area, Odhav, Ahmedabad, Gujarat 382350 Telephone +91-79-2287 0622 +91-79-4025 8900 Fax +91-79-2287 0642 Sales Related marketing@anupengg.com Procurement procurement@anupengg.com	
Atmospheric storage tanks	MECHANICAL	atmospheric	VESSELS	SPARK ENGINEERS	Address: 'J' Block, Plot No. 429, MIDC, Bhosari, Pune - 411 026 Ph:(020) 46768504 / 66113897Telefax:(020) 27130510 / 66113897 Email:info@sparkengineers.co.in	
Atmospheric storage tanks	Mechanical	atmospheric		Murthal Tanks & Vessels	50 K.M Stone(Link Road Kurar) G.T. Road, Murthal, Sonipat 131001 Haryana, India Phone 1: +91 9812003117 Phone 2: +91 9991410000 Phone 3: +91 8254900009 info@murthaltanks.com mtv_murthal@yahoo.co.in	
Atmospheric storage tanks		atmospheric		SYSCON ENGINEERS	Contact Person : Mr. C. A. Benadikar 207, Dhanlaxmi Service Industrial Estate, Above Navneet Motors, L. B. S. Marg, Thane (W) - 400 601. Maharashtra (INDIA) Tel. No. : +91-22-2172 1108, 4088 Telefax No. : +91-22-2172 1497 E-mail :head	
Atmospheric storage tanks	vessels	atmospheric		Jasmino Polymertech Pvt Ltd	Jasmino Polymertech Pvt Ltd M.Perumal (Manager) L ¿¿¿ 61, MIDC Taloja, MIDC Taloja, Raigad - 410208, Maharashtra, India Call Us: +91-9821948287	
Atmospheric storage tanks	MECHANICAL	atmospheric	VESSLES	S. V. Fabricators	S. V. Fabricators Satish Thakor(Proprietor) No. 856/9- E, GIDC Estate, Makarpura, Makarpura Gidc, Vadodara - 390010, Gujarat, InDIA Call Us: +91-9726716894 Send SMS	
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	NICOTRA INDIA PVT LTD		
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	Patels Airflow Limited		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	ADVANCE VENTILATION PVT. LTD.	SUMIT CHAUDHARY, 610, PP Towers, C1,2&3 PP Towers, Netaji Subhash Place, Pitampura, New Delhi, Phone- 0130-2219092-96, Pincode : 110034, Email : sales@advanceventilation.com,	
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	CBDOCTOR VENTILATORS PVT. LTD.	Postal address :3607 / 3608 GIDC Estate, Phase IV, Vatva, Ahmedabad - 382 445Telephone +91 79 40268700, 25841449, 25841152, 25842087, 25840448 FAX : +91 79 40268799, 25842216 (Gujarat) - INDIA Customer Care : +91 9426752941 email: marketing@cbdoctor.c	
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	SARLA		
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	S.K.SYSTEMS PRIVATE LTD.	PLOT NO.150-151 HSIDC IND AREA PH-II KUNDLI, SONEPAT, Phone- Pincode : 131028 Email : sksystem@eth.net; skskundli@gmail.com	
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	KHAITAN		
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	KRUGER		
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	FLAKT		
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	Marathon Electric		
AXIAL FLOW FANS/RE UNITS	Mechanical	Fan	Axial Flow	HYDERABAD POLUTION CONTROLS LIMITED		
BALL VALVES	Mechanical	Valve	Ball	CRESCENT VALVES MFG CO. PVT. LTD	BLUE HAVEN 15 FAROOQ S UMAR STREET MUMBAI Phone- 02223014026 Pincode : 400011 Email : mehboob@crescentvalves.com	"Size upto 50NB Class 800 with MOC as FSS/FCS/Gun Metals and Ball Valves size upto 200NB upto class 150 with MOC as CCS/ CSS".
BALL VALVES	Mechanical	Valve	Ball	WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	DLF Tower-B, Unit No: 1212, 1214 & 1215, 12th Floor, Jasola District Centre, Sarita Vihar, New Delhi - 110044 NEW DELHI Phone- 011-40503345/ 46/ 47 Pincode : 110044 Email : Brijesh.Manchanda@mail.weir	
BALL VALVES	Mechanical	Valve	Ball	BELGAUM AQUA VALVES PVT. LTD.	M-19, INDUSTRIAL ESTATE UDYAMBAG, BELGAUM Phone- 0831-441952, 442194 Pincode : 590008 Email : sales@aquavalv.com	
BALL VALVES	Mechanical	Valve	Ball	DELVAL FLOW CONTROLS PVT. LTD.	Mr. Arun Shiroor 414, 4th Floor, Vishal Chamber, P-1, Sector - 18, Noida Phone- 02169241285 Pincode : 201301 Email : gchoudhary@deltechcontrols.com	MOC Steel only
BALL VALVES	Mechanical	Valve	Ball	Sap Industries Limited	10-A, Krishna Industrial Estate Nr. Sukhrampura Post Office Nagarvel Hanuman Road Ahmedabad Phone- 9879293029 Pincode : 380023 Email : pankaj@sapvalves.com	a. Up to Cl. 800 for sizes 15NB to 50NB with MOC as FCS/FSS only. b. up to CL. 600 for sizes 65NB to 350NB with MOC as CCS/CSS only.
BALL VALVES	Mechanical	Valve	Ball	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	(1) BALL VALVES: FCS/FSS - 1/2" to 2" #800 & CCS/CSS - 2.1/2" to 4" # 150 (2) BALL VALVES: GUN METAL VALVES SIZE 15 NB TO 80 NB - UPTO PN16.0
BALL VALVES	Mechanical	Valve	Ball	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	"Size 15 NB to 50 NB, #800/ #PN16, MOC as FCS/FSS/Gun Metal" and "Size 65 NB to 200 NB, up to #300, MOC as CCS/CSS/CAS".
BALL VALVES	Mechanical	Valve	Ball	INTERVALVE POONAWALLA LTD.	212/2, HADAPSAR, OFF SOLI POONAWALLA ROAD, PUNE Phone- '020-26602630 Pincode : 411028 Email : vkathuria@poonawallagroup.com	Steel ball Valves upto 50NB, #800 and 65NB to 150NB. #150
BALL VALVES	Mechanical	Valve	Ball	Hawa Valves (India) Pvt. Ltd.	Mr. Javed A Hawa R-16 & R-954, MIDC TTC Industrial Area, Sector 8, Rabale, Thane Belapur, Navi Mumbai Phone- 022-67760139 Pincode : 400701 Email : info@hawavalves.com	Size up to 2" & #800 with MOC as FCS & FSS and for size from 65 NB to 150 NB & #150 with MOC as CCS and CSS.
BALL VALVES	Mechanical	Valve	Ball	VALTECH INDUSTRIES	B-5 , NEW SONAL IND.ESTATE SAKI VIHAR ROAD MUMBAI Phone- Pincode : 400072 Email : farooq@valtechindustries.com	"Size 15 NB to 50 NB, #800/ #PN16, MOC as FCS/FSS/FAS/Gun Metal" and "Size 65 NB to 200 NB, up to #150, MOC as CCS/CSS/CAS".
BALL VALVES	Mechanical	Valve	Ball	MICON VALVES (INDIA) PVT. LTD.	7, WADEE MANZIL, 2ND FLOOR, OPP. MEMON CO-OP. BANK, 75-77E, LADY JAMSHEDJI ROAD, MAHIM, MUMBAI Phone- 24460711/0712 Pincode : 400016 Email : miconvalve@vsnl.net	"Size 15 NB to 50 NB, #800/ #PN16, MOC asFCS/FSS/Gun Metal" and "Size 65 NB to 500 NB, up to #600, MOC as CCS/CSS".
BALL VALVES	Mechanical	Valve	Ball	MEVADA ENGINEERING WORKS PVT LTD.	Mr. Rakesh Mistry Unit No 1,Plot No 9,Mistry Industrial Estate,I. B. Patel Road, Goregaon East, Mumbai Phone- 022-42523200 Pincode : 400063 Email : rpm@saturnvalves.com	Size upto 300 NB, CL#300 with MOC as CCS and CSS only;
BALL VALVES	Mechanical	Valve	Ball	HAWA ENGINEERS LTD.	Mr. M. N. Pathan Plot No.129, Near Kashiram Textile Mill, Narol Road, Ahmedabad Phone- 079-25320781 Pincode : 382405 Email : pathan@hawaengltd.com	" Size 15 NB to 50 NB, #800/ #PN16, MOC as FCS/FSS/ Gun Metal "and "Size 65 NB to 600 NB, up to #150, MOC as CCS/CSS/CAS".
BALL VALVES	Mechanical	Valve	Ball	UNIFLOW	Mr. M. T. Palaniyandi SP-9, First Main Road, Ambattur Industrial Estate, Chennai Phone- 9884051834 Pincode : 600058 Email : info@uniflowvalves.com	
BALL VALVES	Mechanical	Valve	Ball	MICROFINISH VALVES PVT LTD.	B161-162, INDUSTRIAL ESTATE, GOKUL ROAD, HUBLI Phone- 2212404,2210611 Pincode : 580030 Email : ajm@microfinishgroup.com	
BALL VALVES	Mechanical	Valve	Ball	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
BALL VALVES	Mechanical	Valve	Ball	Canle Valves Private Limited	No. 52, SIDCO Industrail Estate Pollachi Main Road Coimbatore Phone- 04222679972 Pincode : 641021 Email : marketing@canlevalve.com	"Steel Ball Valves: Size 65 NB to 300NB, #150 & MOC as CCS/CSS"
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	FLUIDLINE VALVES COMPANY PVT.LTD.	Mr. Balwant Mehra K.M. Trade Tower, Unit no. 905, 10thFlr Radisson Blu Hotel), Kaushambi Sec-14 Ghaziabad Phone- 0120-4242204 Pincode : 201010 Email : fluidlinedelhi@gmail.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	WEIR BDK		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	AUDCO		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	SURYA VALVES AND INSTRUMENTS MFG CO		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	ADVANCE VALVES PVT. LTD.	B-33, SECTOR-2, NOIDA Phone- + 91 -120 - 4796900 Pincode : 201301 Email : m.shahnawaz@advancevalves.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED,	23A, NETAJI SUBHAS ROAD, 6TH FLOOR, ROOM NO 6, KOLKATA, Phone- 033-22309598, Pincode : Email : ritauvml@gmail.com, amituvml@gmail.com,	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	TYCO		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	INTERVALVE POONAWALLA LTD.	212/2, HADAPSAR, OFF SOLI POONAWALLA ROAD, PUNE Phone- '020-26602630 Pincode : 411028 Email : vkathuria@poonawallagroup.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	FOURESS ENGG		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	R and D MULTIPLES (METAL CAST) PVT LTD	106, UNITED INDUSTRIAL ESTATE, MOGUL LANE, MAHIM, MUMBAI Phone- 24374430,24371883 Pincode : 400016 Email : rdmultiples@gmail.com,,rdmuldelhi@gmail.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	KEYSTONE		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	BDK		
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	VENUS PUMPS AND ENGG. WORKS	40, STRAND ROAD, Ist FLOOR, KOLKATA Phone- 033-26531546 Pincode : 700001 Email : venus.rajesh68@gmail.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	CRANE PROCESS FLOW TECHNOLOGIES (INDIA) PVT LTD.	Mr. Vipin Kumar Singhal, Solitaire | 5th & 6th Floor, S.No. 131 / 1+2 | ITI Road, Aundh Pune Phone- 8800717115 Pincode : 411007 Email : vkumar@cranecpe.com	
BUTTERFLY VALVE	Mechanical	Valve	Butterfly	PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED		
BUTTERFLY VALVES (WATER SYSTEMS)	Mechanical	Valve	Butterfly	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	ADVANCE VALVES PVT. LTD.	B-33, SECTOR-2, NOIDA Phone- + 91 -120 - 4796900 Pincode : 201301 Email : m.shahnawaz@advancevalves.com	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	CRANE PROCESS FLOW TECHNOLOGIES (INDIA) PVT LTD.	Mr. Vipin Kumar Singhal, Solitaire | 5th & 6th Floor, S.No. 131 / 1+2 | ITI Road, Aundh Pune Phone- 8800717115 Pincode : 411007 Email : vkumar@cranecpe.com	"Cl.#150, PN16, Size up to 450 NB MOC as CI/CCS/CSS/Duplex-SS"
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED,	23A, NETAJI SUBHAS ROAD, 6TH FLOOR, ROOM NO 6, KOLKATA, Phone- 033-22309598, Pincode : Email : ritauvml@gmail.com, amituvml@gmail.com,	MOC-Cast Iron, size from 65 NB to 350 NB having rating of PN10 as per BS EN 593.
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	R and D MULTIPLES (METAL CAST) PVT LTD	106, UNITED INDUSTRIAL ESTATE, MOGUL LANE, MAHIM, MUMBAI Phone- 24374430,24371883 Pincode : 400016 Email : rdmultiples@gmail.com,,rdmuldelhi@gmail.com	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	DLF Tower-B, Unit No: 1212, 1214 & 1215, 12th Floor, Jasola District Centre, Sarita Vihar, New Delhi - 110044 NEW DELHI Phone- 011-40503345/ 46/ 47 Pincode : 110044 Email : Brijesh.Manchanda@mail.weir	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	VENUS PUMPS AND ENGG. WORKS	40, STRAND ROAD, Ist FLOOR, KOLKATA Phone- 033-26531546 Pincode : 700001 Email : venus.rajesh68@gmail.com	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	INTERVALVE POONAWALLA LTD.	212/2, HADAPSAR, OFF SOLI POONAWALLA ROAD, PUNE Phone- '020-26602630 Pincode : 411028 Email : vkathuria@poonawallagroup.com	
BUTTERFLY VALVES(WATER SYSTEMS)	Mechanical	Valve	Butterfly	PENTAIR VALVES & CONTROLS I PVT LTD(FOR	SEMPELL GmbH MAKE VALVES ONLY) R-701 , TTC MIDC INDL ESTATE , RABALE NAVI MUMBAI Phone- Pincode : 400708 Email : bjha@tycoint.com	
CABLE GLAND	Electrical	cable	Glands	COMMET		
CABLE GLAND	Electrical	cable	Glands	DOWELL		
CABLE GLAND	Electrical	cable	Glands	SUNIL&CO		
CABLE GLAND	Electrical	cable	Glands	JAINSON		
CABLE GLAND	Electrical	cable	Glands	ARUP ENGINEERING		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
CAST IRON GATE/GLV/NRV/SRV	Mechanical	Valve	CAST IRON GATE/GLV/NRV/SRV	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	(1) CARBON IRON GATE VALVES: 65 NB TO 450 NB (UPTO PN-16.0) (2) CARBON IRON GLOBE VALVES & NON RETURN VALVES: 65 NB TO 150 NB (UPTO PN-16.0)
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	NICOTRA INDIA PVT LTD	Kasna Village, Greater Noida, Uttar Pradesh 201310 Phone: 099110 48003	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	ADVANCE VENTILATION PVT. LTD.	SUMIT CHAUDHARY, 610, PP Towers, C1,2&3 PP Towers, Netaji Subhash Place, Pitampura, New Delhi, Phone- 0130-2219092-96, Pincode : 110034, Email : sales@advanceventilation.com,	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	Patels Airflow Limited	Vatva, Ahmedabad - 382445, Gujarat. India. PHONE: +91-79-25831536 +91-79-25830658 +91-79-40200800	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	DRAFT-AIR INDIA PVT. LTD.	Head Office 3702 - B & C, Phase-IV, B/h. New Nirma, GIDC, Vatva, Ahmedabad 382 445 INDIA. Phone +91 79 4023 9898 , 40239800 Fax +91 79 2584 1867	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	KRUGER	TEL: 91 9960558899 91 9975577211 FAX: 91 2527240075	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	SARLA	10A, ALIPORE PARK PLACE, 402, ANANDKANAN KOLKATA WB 700027 IN siwlkolkata@saralafans.com	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	Marathon Electric	708, 5I6-518, Antriksh Bhawan5th Floor, 22 K.G.Marg New Delhi - 110001 011-43509363, 011-43509364	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	CBDOCTOR VENTILATORS PVT. LTD.	Postal address :3607 / 3608 GIDC Estate, Phase IV, Vatva, Ahmedabad - 382 445Telephone +91 79 40268700, 25841449, 25841152, 25842087, 25840448 FAX : +91 79 40268799, 25842216 (Gujarat) - INDIA Customer Care : +91 9426752941 email: marketing@cbdoctor.c	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	S.K.SYSTEMS PRIVATE LTD.	PLOT NO.150-151 HSIDC IND AREA PH-II KUNDLI, SONEPAT, Phone- Pincode : 131028 Email : sksystem@eth.net; skskundli@gmail.com	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	HYDERABAD POLUTION CONTROLS LIMITED	IDA Jeedimetla, Chinthal, Quthbullapur, Hyderabad, Telangana 500054 Mr. S Gopala Krishnan Nair Ph : +91-40-23090033 Fax : +91-40-23095119	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	COMEFRI	Guangzhou Comefri (China) Co.Ltd Address Suite 1201, North Tower, New World Time Center No. 2191, Guang Yuan Dong Road, Guangzhou 510500, P. R. China Guangdong Province People's Republic of China Telephone 0086-20-87731890 / 1 Fax 0086-20-87731893 Company	
CENTRIFUGAL FAN	Mechanical	Fan	Centrifugal	FLAKT	3B, Ecotech-II, Udyog Vihar, Greater Noida, Dist. GB Nagar Greater Noida- 201306(UP), India salessupport.in@flaktgroup.com +91 120 4982050	
CHAIN PULLEY BLOCK	Package			TUOBRO FURGUSON (INDIA) PVT LTD	84/A , AJC BOSE ROAD, 2ND FLOOR , FLAT NO.205, KOLKATA-700 014 KOLKATA Phone- 23501955 Pincode : 700014 Email : toubro@hotmail.com	UPTO 10 TONNE.
CHAIN PULLEY BLOCK	Package			TRACTEL TIRFOR INDIA PVT. LTD.	DODHALA ROAD, PO- PRITHLA PALWAL FARIDABAD FARIDABAD Phone- 9810000294 Pincode : 121102 Email : dsctractel@gmail.com	
CHAIN PULLEY BLOCK	Package			BAKELITE ELECTRICAL MFG. CO. PVT. LTD.	74CD, GOVT. INDL. ESTATE, CHARKOP NEAR GANESH NAGAR, KANDIVALI WEST MUMBAI Phone- 02228682763 Pincode : 400067 Email : bemcopvt@yahoo.com	
CHAIN PULLEY BLOCK	Package			TECHNO INDUSTRIES	Mr. Nirag Chokshi Plot No-613, Phase-IV, GIDC, Vatva, Ahmedabad Phone- 079-25830742 Pincode : 382445 Email : info@technoind.com	
CHAIN PULLEY BLOCK	Package			Universal Hoist-O-Fabrik	Mr. Pradeep K. Kamath Plot No. B/71, Road No. 21 Wagle Industrial Estate Thane Phone- 9820274412 Pincode : 400604 Email : universalhoist@yahoo.com	
CHAIN PULLEY BLOCK	Package			BRADY & MORRIS ENGINEERING CO. LTD.	Mr. M. Kumar Plot No. 505, Phase IV, GIDC Vatva, Ahmedabad Phone- 079-40236400 Pincode : 382445 Email : mkumar@bradys.in	
CHAIN PULLEY BLOCK	Package			CENTURY CRANE ENGINEERS PVT. LTD.	16/6, MATHURA ROAD, FARIDABAD FARIDABAD Phone- 0129- 4048863 Pincode : 121 002 Email : centurycranes@gmail.com	
CONTROL PANEL	Electronics	Panel	Control	CONTROL & SWITCHGEAR		
CONTROL PANEL	Electronics	Panel	Control	PYROTECH ELECTRONICS PVT. LTD.	Unit-IV, A-193, M.I.A. Dadri, UDAIPUR Phone- 2492122,31,34 Pincode : 313003 Email : pyrotech@pyrotechindia.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
CONTROL PANEL	Electronics	Panel	Control	RITTAL		
CONTROL PANEL	Electronics	Panel	Control	INDUSTRIAL CONTROLS & APPLIANCES PVT LTD	47, CHAKALA ROAD, ANDHERI(EAST), MUMBAI Phone- 28344494,28221532 Pincode : 400099 Email : indconapp@vsnl.com	
CONTROL PANEL	Electronics	Panel	Control	GE POWER		
CONTROL PANEL	Electronics	Panel	Control	POSITRONICS		
CONTROL PANEL	Electronics	Panel	Control	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
CONTROL PANEL	Electronics	Panel	Control	L and T- SARGENT and LUNDY LTD	L & T ENERGY CENTER, CHHANI JAKAT NAKA, VADODARA Phone- 2772390,2776391 Pincode : 390002 Email : ltsl@ltecd.ltindia.com	
CONTROL PANEL	Electronics	Panel	Control	HOFFMAN		
CONTROL VALVE	Electronics	Valve	Control	SPX Flow Technology	Patidar Showroom, Chotalal Chaly, Adinath Rd, G I D C Industrial Area, Odhav, Ahmedabad, Gujarat 382415	
CONTROL VALVE	Electronics	Valve	Control	Holter Regelarmaturen Verwaltungs GmbH	Helleforthstraße 58, 33758 Schloß Holte-Stukenbrock, Germany +49 5207 89030	
CONTROL VALVE	Electronics	Valve	Control	BOMAFA SPECIAL VALVE SOLUTIONS PVT LTD	Mr. K.M. Anklesaria/ R. M. Anklesaria Plot No: 285/2, Panchratna Estate, Near Ramol Bridge, Vatva Ahmedabad Phone- 079-40083825 Pincode : 382445 Email : info@bomafa-india.com	
CONTROL VALVE	Electronics	Valve	Control	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
CONTROL VALVE	Electronics	Valve	Control	Mascot Valves Pvt. Ltd.	166-167 GIDC Naroda Ahmedabad Phone- 0792282 1619 Pincode : 382330 Email : dom.sales@mascotvalves.com	
CONTROL VALVE	Electronics	Valve	Control	Valvitalia S.P.A. ,	Mr. Salvatore Ruggeri Via Tortona 69, Rivanazzano (Pavia)Phone- +39-03839459875 Pincode : 27055 Email : dario.torluccio@valviatalia.com	
CONTROL VALVE	Electronics	Valve	Control	R.K.CONTROL INSTRUMENTS PVT. LTD.	PLOT NO.A-250, OPP.POLICE STATION, WAGLE INDUSTRIAL ESTATE, THANE Phone- 25820943/2331 Pincode : 400604 Email : rkcipl@vsnl.com ; rkcinpvt@bol.net.in	For subcritical power plant up to 150MW
CONTROL VALVE	Electronics	Valve	Control	Severn Glocon India Pvt. Ltd.	F96 & F97, Sipcot Industrial Park, Irungattukottai, Chennai, Phone- 044-47104200, Pincode : 602117, Email : info@severnglocon.co.in,	
CONTROL VALVE	Electronics	Valve	Control	FORBES MARSHALL ARCA PVT.LTD.	A-34/35 , MIDC ESTATE, H-BLOCK, PIMPRI, PUNE, Phone- 020-27442020, Pincode : 411018 Email : mnadgaundi@forbesmarshall.com	No technical limit exists except for feed control valve. For feed control valves, approved up to sub-critical power plants of 600 MW rating.
CONTROL VALVE	Electronics	Valve	Control	DRESSER VALVE INDIA PVT. LTD	Mr. Raj Raman/Mr. Rajkumar Moria S.F. No: 608,Chettipalayam Road, Echanari Post, Coimbatore Phone- +91-98451 19085 Pincode : 641021 Email : Anoop.Ramachandran@ge.com	
CONTROL VALVE	Electronics	Valve	Control	SAMSON CONTROLS PVT. LTD.	Mr. Atul raje-MD D 281, MIDC Ranjangaon Ta Shirur Pune Phone- 02067246600 Pincode : 412220 Email : sales@samsoncontrols.net	
CONTROL VALVE	Electronics	Valve	Control	WALDEMAR PRUSS ARMATURENFABRIK GMBH	Mr. Winfried Dremhel Schulenburgerlandstrasse 261, Hannover Phone- +49-511279260 Pincode : 30419 Email : dremhel@pruss.de; vogel@pruss.de	
CONTROL VALVE	Electronics	Valve	Control	SUZHOU DELAN ENERGY SCIENCE & TECHNOLOGY CO., LTD.	No 566 Fangqiao Road Caohu Industrial Park, Xiangcheng Economic Development Zone, Suzhou Phone- 008618012776062 Pincode : 215143 Email : jeanielei@delan-valve.com	
CONTROL VALVE	Electronics	Valve	Control	KSB MIL CONTROLS LTD.	Mr.Jacob Cherian/Mr.Geo Jolly Meladoor, Annamanada P.O. MALA, Thrissur Phone- 0480-2695700 Pincode : 680741 Email : biju.simon@ksb.com	
CONTROL VALVE	Electronics	Valve	Control	DAUME REGELARMATUREN	AUMVN INDUSTRIAL PRODUCTS Address: Building No-3, Flat No-11, Vijay Vilas Complex, Thane West, Mahrashtra, India, 400615, India Phone: +91.2225971689 Fax: +91.22.2597.1672 madhu@aumvn.com	
CONTROL VALVE	Electronics	Valve	Control	Koso India Private Limited,	H 33 & 34, MIDC, Ambad, Nashik, Phone- 09650233433 Pincode : 422010, Email : jetmal.gour@koso.co.in	
CONTROL VALVE	Electronics	Valve	Control	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	147, KARAPAKKAM VILLAGE, CHENNAI Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	
COOLING TOWER (FRP)	Mechanical	Cooling Tower	FRP	PAHARPUR		
COOLING TOWER (FRP)	Mechanical	Cooling Tower	FRP	BELL		
COOLING TOWER (FRP)	Mechanical	Cooling Tower	FRP	FLOWTECH		
COOLING TOWER (FRP)	Mechanical	Cooling Tower	FRP	MIHIR		
COOLING TOWER (FRP)	Mechanical	Cooling Tower	FRP	PCT		
COOLING TOWERS	Mechanical			HAMON SHRIRAM COTTRELL PVT. LTD.,	Main Frame,3A-8A, Ground Floor, Royal Plams Complex,Near Aarey Milk Col. Goregaon (E), Mumbai Phone- 09920751407, Pincode : 400065 Email : abhijit.bagde@hamon.com,	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
COOLING TOWERS	Mechanical			NATIONAL BUILDINGS CONSTRUCTION CORPORATION LTD.	Phone- Pincode : Email : bd.nbcc@nic.in	
COOLING TOWERS	Mechanical			Hamon Thermal Europe, S.A.	Axis Parc - Rue Emile Francqui 2, 1435 Mont-Saint-Guibert, Belguim,Phone- +32 10 390 500 Pincode : Email : info.hteb@hamon.com	
COOLING TOWERS	Mechanical			GAMMON INDIA LTD.	GAMMON HOUSE, VEER SAVARKAR MARG, P.O.BOX NO.9129, PRABHADEVI, MUMBAI Phone- 24306761,56614000 Pincode : 400025 Email : gammon@vsnl.com	
COOLING TOWERS	Mechanical			PAHARPUR COOLING TOWERS LTD.	PAHARPUR HOUSE, 8/1/B, DIAMOND HARBOUR ROAD, KOLKATA Phone- 24792050, 24791976 Pincode : 700027 Email : bk.shayani@paharpur.com	
COOLING TOWERS	Mechanical			PALTECH COOLING TOWERS & EQUIPMENTS LIMITED	Mr. H.P. Yadav B-604 ,Sushant Lok ,Phase-1, Gurgaon Phone- 0124-4499700 Pincode : 122002 Email : paltech@paltech.net.in	For IDCT only;
CS ERW Pipe				Maharashtra Seamless Limited	Pipe Nagar, B. K. G. Road, Raigad, Maharashtra 402126 फोन: 02194 238 511	for FOHS upto 350 nb
CS ERW Pipe				Jindal Pipes Limited	CORPORATE OFFICEJINDAL CORPORATE CENTRE Plot No 30, Institutional Sector-44, Gurgaon - 122001 Haryana (India) Tel. : +91 124 2574325 / 26, 4624000 Fax : +91 124 2574327 Email : contact@jindalpipe.com For Business Enquiry (Domestic) Mob: +91 - 9910849877	for FOH upto 350 nb
CS ERW Pipe				Surya Roshni Limited	(ERW Steel Pipe, MS, Galvanized, Hollow Section & CR Strip) Prakash Nagar, Delhi-Rohtak Road, Bahadurgarh -124507 (Haryana) India www.surya.co.in Phone No: +91-11-47108000 +91 1276 241540, 241980/81/82 Fax: +91 01276 241886 Email: bgh@surya.in	upto 400 nb for FOHS
CS ERW Pipe				Ratnamani Metals & Tubes Ltd	Registered & Corporate Office 17, Rajmugat Society, Naranpura Cross Roads, Ahmedabad - 380 013 Gujarat, India. info@ratnamani.com +91 79 2741 5501/2/3/4 +91 79 2748 0999	
CS ERW Pipe				SAIL	DGM (PR) & CoC Rourkela Steel Plant Rourkela-769011,Odisha Email : rsp[dot]coc[at]gmail[dot]com Tel : 91 - 0661- 2510050	
CS ERW pipes				Indus Tubes Limited	GD - ITL Tower, Top Floor, B - 8, Netaji Subhash Place Ring Road, Pitampura, New Delhi - 110034. Phone : +91-11-27352981 - 84. Fax : +91-11-47002413 / 27352985 E-mail : industubes@yahoo.com, arvindkjain_industubes@yahoo.in Website : www.industubes.	
CS ERW pipes				Welspun Corp Ltd	Welspun Corp. Ltd., Vadadla, Bharuch, Gujarat फोन: 02836 662 079	
CS ERW pipes				Mukat Pipes Limited	Rajpura-Patiala Road, Rajpura, 140401 Distt. Patiala, (NH-7) (Punjab) INDIA Email: mukat@mukatpipes.com, mukatpipes@gmail.com Telephone: (91) 01762-225040 Fax: (91) 01762-222390 Marketing/Enquiry Mob. No. (91) 85912-03725 & 93578-95440	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
CS ERW pipes				Pratibha Pipes & Structural Ltd.	Unit No. 1/B-56 & 1/B-57, 1st Floor, Phoenix Paragon Plaza, Phoenix Market City, LBS Road, Kurla (W), Mumbai – 400070. Maharashtra, India. Contact No: +91 - 22 - 39559999 (Board) E-mail: info@pratibhagroup.com	
CS ERW pipes				Tata Steel Limited	P.O. Bistupur Jamshedpur - 831 001 Jharkhand, India 1 800 108 8282	
CS ERW Pipes				Samshi Pipes Industries Limited	Samshi Pipes Industries Limited HITESH PATEL(Customer Relationship Manager) Plot No. E/ 9, Savli GIDC Estate, Manjusar, Vadodara - 391165, Gujarat, India Call Us: +91-9879854043	
CS ERW pipes				Lalit Pipes & Pipes Limited	#212, Hermes Atrium, Sector-11, C.B.D. Belapur, Navi Mumbai, Maharashtra. India – 400 614 +91 22 2756 11 69 info@lalitgroup.com | marketing@lalitgroup.com	
CS ERW Pipes				APL Apollo Tubes Limited	CORPORATE OFFICE Noida Tapasya Corporate Heights Tower A 4th Floor, Sector 126 Noida Uttar Pradesh 201303 (India) Tel: +91-120-4742700/701	
CS ERW pipes				PSL LIMITED	पता: B-96, Psl House, Greater Kailash I, New Delhi, Delhi 110048 फोन: 011 2923 8642	
CS ERW Pipes				DADU PIPES PRIVATE LIMITED	Dadu Dayal House, C-101, RDC, Rajnagar, Ghaziabad-201001, (U.P.) Phone No.+91-120-2705614 Mobile.+91-9268404282 Fax No.+91-120-2705613 Emailsatishagarwal@dadupipes.com , info@dadupipes.com Websitewww.dadupipes.com	
CS ERW Pipes				JCO Gas Pipe Limited	B-2,Borgaon Industrial Area, MPAKVN Growth Centre,Borgaon, Tehsil Sausar, Chhindwara, Madhya Pradesh 480106 011 4710 5100	
CS Seamless Pipe				Jindal Pipes Limited	CORPORATE OFFICEJINDAL CORPORATE CENTRE Plot No 30, Institutional Sector-44, Gurgaon - 122001 Haryana (India) Tel. : +91 124 2574325 / 26, 4624000 Fax : +91 124 2574327 Email : contact@jindalpipe.com For Business Enquiry (Domestic) Mob: +91 - 9910849877	for FOH upto 350 nb
CS Seamless Pipe				RMG Alloy Steel Limited	RMG Alloy Steel Ltd. B/9, Trade World, Kamala Mills Compound, Senapati Bapat Marg, Lower Parel (West), Mumbai - 400 013, Maharashtra, India. Phone : +91 22 266136000 / 24908000 Fax : +91 22 24908020 Email: sales_pipes@remi.welspun.com sales_steel	
CS Seamless Pipe				The Indian Seamless Metal Tubes Limited		
CS Seamless Pipe				Maharashtra Seamless Limited	Pipe Nagar, B. K. G. Road, Raigad, Maharashtra 402126 फोन: 02194 238 511	for FOHS upto 350 nb
DUAL PLATE CHECK VALVES	Mechanical	Valve	check dual plate	ADVANCE VALVES PVT. LTD.	B-33, SECTOR-2, NOIDA Phone- + 91 -120 - 4796900 Pincode : 201301 Email : m.shahnawaz@advancevalves.com	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	OTOKLIN GLOBAL BUSINESS LIMITED	R-02, "Remi Bizcourt", PLOT NO.09 SHAH INDUSTRIAL AREA,VEERA DESAI RAOD ANDHERI (WEST) MUMBAI Phone- 022 - 2673 2134/35 Pincode : 400053 Email : sales@otoklin.com	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	NISAN SCIENTIFIC PROCESS EQUIPMENT PVT. LTD.	Mr. Nitin S. Nikam R-587/1, M.I.D.C. RABALE, T.T.C. INDL. AREA NAVI MUMBAI Phone- 022-27691220 Pincode : Email : sales@nisanprocess.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
DUPLEX STRAINER	Mechanical	Strainer	Duplex	SUNGOV ENGINEERING PVT. LTD.	MR. S PRAKASH 160 BABA NAGAR, VILLIVAKKAM CHENNAI Phone- 044 26501404 Pincode : 600049 Email : domesticsales@sungov.com	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	FILTERATION ENGINEERS (I) PVT. LTD.	Plot No. W-62 (B) T.T.C Industrial Area MIDC , Rabale Navi Mumbai Phone- 02227608501 Pincode : 400701 Email : sales@feipl.com	
Duplex STRAINER	Mechanical	Strainer	Duplex	Jaypee Industries Pvt.Ltd.	Pocket K, Sarita Vihar, New Delhi, Delhi 110076 mob +91-9810115301	
Duplex STRAINER	Mechanical	Strainer	Duplex	Sungov Engineers Pvt.Ltd.	160, Baba Nagar, Villivakkam,	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	JAY-EESH ENGINEERING COMPANY	Mr.JAYWANT MISTRY UNIT NO.17/20,ACHARYA INDUSTRIAL ESTATE, ANDHERI KURLA ROAD MUMBAI Phone- 9819914473 Pincode : 400072 Email : jayeesh_engg@rediffmail.com	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	ACME FLUID SYSTEMS	Mr. Rakesh Sharma 152/2, Road No. 5, GIDC Kathwada, Ahmedabad Phone- 0120-2541259 Pincode : 383430 Email : rakesh@strainersindia.com	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	MULTITEX FILTRATION ENGINEERS LIMITED	FILTRATION DIVISION, 217, HANS BHAWAN, BAHADURSHAH ZAFAR MARG, NEW DELHI Phone- 23378015/0923/0479 Pincode : 110002 Email : rajesh@multitexfilters.com	
DUPLEX STRAINER	Mechanical	Strainer	Duplex	BOMBAY CHEMICAL EQUIPMENTS	Mr. G. S. Luthra, Bombay Rubber Works Compound, Off. Saki Vihar Road, Near Universal Business Park,Andheri (E) Mumbai Phone- 022-66964249 Pincode : 400072 Email : sales@bombaychem.com	Flow upto 2270 CuM/Hr
DUPLEX STRAINER	Mechanical	Strainer	Duplex	GUJARAT OTOFILT	Mr. Mahesh I Patel Plot No. 3712 & 3714, Phase IV, GIDC Vatva B/H New Nirma, Ahmedabad Phone- 079-25841164 Pincode : 382445 Email : gujfilter@gmail.com	Flow upto 2700 CuM/Hr
DUPLEX STRAINER	Mechanical	Strainer	Duplex	GRAND PRIX ENGINEERING PVT. LTD.	Mr. B.S. Dhillon, Plot No. 82, Sector 25, Faridabad Phone- 0129-4097716 Pincode : 121004 Email : bsdhillon@grandprixfilters.com	
Duplex STRAINER	Mechanical	Strainer	Duplex	ALLWEILER INDIA PRIVATE LIMITED	C-1/10 , GIDC ESTATE VAPI Phone- Pincode : 396195 Email : sureshchandra.sharma@tushacopumps.com	
Duplex STRAINER	Mechanical	Strainer	Duplex	MULTITEX FILTRATION ENGINEERS LIMITED	FILTRATION DIVISION, 217, HANS BHAWAN, BAHADURSHAH ZAFAR MARG, NEW DELHI Phone- 23378015/0923/0479 Pincode : 110002 Email : rajesh@multitexfilters.com	
ELECTRIC HOIST	Package			Mangla Hoists Pvt Ltd	Mr. Nishant Mangla Jindal House, 1/9, Asaf Ali Road New Delhi Phone- 011-23237575 Pincode : 110002 Email : mangla@mangla.in	
ELECTRIC HOIST	Package			CONSOLIDATED HOISTS PVT LTD	PLOT NO.29/30, CO-OP.INDUSTRIAL ESTATE, GULTEKDI, PUNE-411037, PUNE Phone- 24271426,28-30 Pincode : 411037 Email : dpk@chpl.in	
ELECTRIC HOIST	Package			REVA INDUSTRIES LTD.	PLOT NO-28 , SECTOR 25 NIT , FARIDABAD Phone- 9899484741 Pincode : 121004 Email : grsharma@revacranes.com	
ELECTRIC HOIST	Package			CENTURY CRANE ENGINEERS PVT. LTD.	16/6, MATHURA ROAD, FARIDABAD FARIDABAD Phone- 0129- 4048863 Pincode : 121 002 Email : centurycranes@gmail.com	
ELECTRIC HOIST	Package			BRADY & MORRIS ENGINEERING CO. LTD.	Mr. M. Kumar Plot No. 505, Phase IV, GIDC Vatva, Ahmedabad Phone- 079-40236400 Pincode : 382445 Email : mkumar@bradys.in	
ELECTRIC HOIST	Package			Universal Hoist-O-Fabrik	Mr. Pradeep K. Kamath Plot No. B/71, Road No. 21 Wagle Industrial Estate Thane Phone- 9820274412 Pincode : 400604 Email : universalhoist@yahoo.com	
ELECTRIC HOIST	Package			Alpha Services	Mr. RB Dubey - President SPA-531, RIICO INDUSTRIAL AREA BHIWADI Phone- 01493-645136 Pincode : 301019 Email : rbd@alphaservices.co.in	
ELECTRIC HOIST	Package			TECHNO INDUSTRIES	Mr. Nirag Chokshi Plot No-613, Phase-IV, GIDC, Vatva, Ahmedabad Phone- 079-25830742 Pincode : 382445 Email : info@technoind.com	
ELECTRIC HOIST	Package			EDDY CRANES PVT. LTD.	3/23, TARDEO AIRCONDITIONED MARKET, TARDEO, MUMBAI Phone- 24945103,24961798 Pincode : 400034 Email : eddycranes@vsnl.com	
ELECTRIC HOIST	Package			TRACTEL TIRFOR INDIA PVT. LTD.	DODHALA ROAD, PO- PRITHLA PALWAL FARIDABAD FARIDABAD Phone- 9810000294 Pincode : 121102 Email : dsctractel@gmail.com	
ELECTRIC HOIST	Package			Grip Engineers Pvt. Ltd.,	Mr. Dwarkesh Lajpal Piyala Road, P.O. Sikri, Ballabhgarh, Faridabad, Phone- 0129-2205004 Pincode : 121102 Email : fbd@gripengineers.com,	
FIRE DAMPER	Mechanical	Dampener	Fire	RAVISTAR (SYSTEM AIR)		
FIRE DAMPER	Mechanical	Dampener	Fire	CARRYAIRE		
FIRE DAMPER	Mechanical	Dampener	Fire	TSC		
FITTINGS	Mechanical	FITTINGS		SIDDARTH & GAUTAM		
FITTINGS	Mechanical	FITTINGS		M.S. FITTINGS		
FITTINGS	Mechanical	FITTINGS		METAL LLOYDS		
FITTINGS	Mechanical	FITTINGS		GUJRAT INFRA PIPES		
FITTINGS	Mechanical	FITTINGS		TUBE PRODUCTS		
FITTINGS	Mechanical	FITTINGS		PIPEFIT ENGINEERS		
FITTINGS	Mechanical	FITTINGS		NL HAZRA		
FITTINGS	Mechanical	FITTINGS		TRUE FORGE		
FITTINGS	Mechanical	FITTINGS		EBY		
FITTINGS	Mechanical	FITTINGS		EDWARDS		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
FLOAT VALVES	Mechanical	Valve	float	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
FLOAT VALVES	Mechanical	Valve	float	G.M. DALUI AND SONS PVT.LTD.	8, KUCHIL GHOSAL LANE, KADAMTALA, HOWRAH Phone- 26438929/4889 Pincode : 711101 Email : dassk15@gmail.com	
FLOAT VALVES	Mechanical	Valve	Float	GM DAULI & SONS		
FLOAT VALVES	Mechanical	Valve	float	H.SARKER and COMPANY	13, CROOKED LANE, HOWRAH Phone- 9163692218 Pincode : 711113 Email : hsblt09@gmail.com ; hs_newdelhi@yahoo.comhsblt09@gmail.com	
FLOAT VALVES	Mechanical	Valve	Float	H.SARKER and COMPANY	13, CROOKED LANE, HOWRAH Phone- 9163692218 Pincode : 711113 Email : hsblt09@gmail.com ; hs_newdelhi@yahoo.comhsblt09@gmail.com	
FLOAT VALVES	Mechanical	Valve	Float	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
FLOW ELEMENT	Electronics	element	flow	IL		
FLOW ELEMENT	Electronics	element	flow	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	
FLOW ELEMENT	Electronics	INSTRUMENTS	Flow meter	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	
FLOW ELEMENT	Electronics	INSTRUMENTS	Flow meter	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
FLOW ELEMENT	Electronics	element	flow	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	
FLOW ELEMENT	Electronics	INSTRUMENTS	Flow meter	TM TECNOMATIC SPA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com	
FLOW ELEMENT	Electronics	element	flow	MINCO		
FLOW ELEMENT	Electronics	element	flow	BALIGA LIGHTING EQPT PVT LTD		
FLOW ELEMENT	Electronics	INSTRUMENTS	Flow meter	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	
FLOW ELEMENT	Electronics	element	flow	LIGHTING EQUIP		
FLOW ELEMENT	Electronics	element	flow	BRISTOL BABCOCK		
FLOW ELEMENT	Electronics	element	flow	ENGINEERING SPECIALITIES		
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum Phone- 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com	
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	Mr. Raghavendra M. Kulkarni D2-49/50, Tivim Industrial Estate, Karaswada Mapusa Phone- 0832-2257059 Pincode : 403526 Email : gicflowelement@giconindia.com	
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	HYDROPNEUMATICS PVT. LTD.	Mr. DM Bichu G/B, Hill Crown Apts., College Road Mapusa Phone- 0832-2360364 Pincode : 403507 Email : ajayrc@hydropneumatics.co.in	
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	
FLOW ELEMENT - NOZZLE	Electronics	Element	flow nozzle	MINCO (INDIA) PRIVATE LIMITED	Mr. Rajeev Vasudeva, D/35, TIVIM INDUSTRIAL ESTATE, KARASWADA, MAPUSA, Goa, Phone- 9313637073 Pincode : 403526, Email : gicdelhi@general-gauges.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	MINCO (INDIA) PRIVATE LIMITED	Mr. Rajeev Vasudeva, D/35, TIVIM INDUSTRIAL ESTATE, KARASWADA, MAPUSA, Goa, Phone- 9313637073 Pincode : 403526, Email : gicdelhi@general-gauges.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	CHEMTROLS INDUSTRIES PVT. LTD.	Mr. K. NANDAKUMAR AMAR HILL, SAKI VIHAR ROAD, POWAI, MUMBAI Phone- 022-67151261 Pincode : 400072 Email : manikandan@chemtrols.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	TANSA EQUIPMENTS PVT. LTD.	Mr. Vardhan Tamhankar, Unit No35/36/41,Om Anand Industrial Est. Mohanjee Sundarjee Road,Raghunath Nagar, Thane Phone- 022-25832323 Pincode : 400604 Email : tansaindia@gmail.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone-2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum Phone- 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	HYDROPNEUMATICS PVT. LTD.	Mr. DM Bichu G/B, Hill Crown Apts., College Road Mapusa Phone- 0832-2360364 Pincode : 403507 Email : ajayrc@hydropneumatics.co.in	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	Mr. Raghavendra M. Kulkarni D2-49/50, Tivim Industrial Estate, Karaswada Mapusa Phone- 0832-2257059 Pincode : 403526 Email : gicflowelement@giconindia.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone-9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
FLOW ELEMENT - ORIFICE	Electronics	Element	flow orifice	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	
FLOW METER	Electronics	Instrument	meter flow	PLACKA		
FLOW METER	Electronics	Instrument	meter flow	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
FLOW METER	Electronics	Instrument	Flow meter	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	Mr V. K. Pandit/Mr Ashish Shaha 17-20, Royal chambers, Paud Road Pune Phone- 9370469466 Pincode : 411038 Email : sales@eurekaflow.com	
FLOW METER	Electronics	Instrument	meter flow	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone-9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	
FLOW METER	Electronics	Instrument	meter flow	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone-9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
FLOW METER	Electronics	Instrument	meter flow	TRAC		
FLOW SWITCH	Electronics	Instrument	Switch flow	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
FLOW SWITCH	Electronics	Instrument	Switch flow	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
FLOW SWITCH	Electronics	Instrument	Switch flow	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone-9810005826 Pincode : 110 020 Email : sales@vautomat.com	
FLOW SWITCH	Electronics	Instrument	Switch flow	DK INSTRUMENTS		
FLOW SWITCH	Electronics	Instrument	Switch flow	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	
FLOW SWITCH	Electronics	Instrument	Switch flow	SEIMENS		
FLOW TRANSMITTER	Electronics	Transmitter	FLOW	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
FRP Tanks				Polyplast Chemi-Plants (I) Pvt. Ltd.	Thakore Industrial Estate, Kurla-Kirol Road, Vidyavihar (West), Mumbai - 400 086, Maharashtra, India. + 91-22-25116659 / 25112294 25162450 (022) 25117698	
FRP tanks				Deepa Composite India Private Limited	Deepa House, Plot No. 91/5B, Kasgoan, Opposite Chanderi Dhaba Badlapur-Karjat Road, District Thane, Badlapur East, Badlapur-421505, Maharashtra, India Mahesh Panchal (Business Manager)	
FRP Tanks				FRP Coroseal Industries	Plot-01,NH-05,Lankelapalem, ♂ Visakhapatnam(AP), Andhra Pradesh, India.	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
FRP Tanks				Global Composites LLC	Address: P.O.Box: 29722, Ras Al Khaimah, UAE Phone: + 971 7 2435237 Fax: + 971 7 2435239 Email: gc@global-composite.com Web: www.global-composite.com	
FRP Tanks				Chemical Process Equipments Pvt. Ltd. (CPE),	BSD Marg Govandi, Mumbai 400088, India +91 22 67230500 +91 22 2556 2248 cpe@vsnl.com	
FRP Tanks				EPP Composites Private Limited	Jayraj Shah Plot No. 2646, Kranti Gate Main Road, GIDC Rajkot - 360021 Gujarat, India Get Directions https://www.eppcpl.com	
FRP Tanks				JR Fibreglass Industries Pvt. Ltd.	Add -1/21, Rocky Industrial Estate, I. B. Patel Road, Goregaon (East), Mumbai - 400 063, INDIA. Tel -+91-(0)22-26853603/04 Fax -+91-(0)22-26853606 Email -purchase@jrfibreglass.com (Purchase Department) sales@jrfibreglass.com (Sales/Marketing	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	SHIVADURGA		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	BANKIM & COMPANY		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	KBL		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	FLUID LINE		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	VENUS PUMPS AND ENGINEERING WORKS.	40, STRAND ROAD, Ist FLOOR, KOLKATA Phone- 033-26531546 Pincode : 700001 Email : venus.rajesh68@gmail.com	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	HI –TECH		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	AUDCO		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	SURYA VALVES AND INSTRUMENT MANUFACTURING		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	BOMBAY METAL & ALLOYS		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	SANT VALVES		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	GM DAULI & SONS		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	H.SARKER and COMPANY	13, CROOKED LANE, HOWRAH Phone- 9163692218 Pincode : 711113 Email : hsblt09@gmail.com ; hs_newdelhi@yahoo.comhsblt09@gmail.com	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	FOURESS ENGG		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	BDK		
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	KIRLOSKAR BROTHERS LTD.	KIRLOSKAR PRESS COMPOUND, UDYOG BHAWAN,TILAK ROAD, PUNE Phone- 2447550,240672 Pincode : 411002 Email : kblin@kbl.co.in; gosain@del.kbl.co.in	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	
GATE/GLOBE VALVES (CI)	Mechanical	Valve	GATE/GLOBE -CI	CRESCENT VALVES MFG CO. PVT. LTD	BLUE HAVEN 15 FAROOQ S UMAR STREET MUMBAI Phone- 02223014026 Pincode : 400011 Email : mehboob@crescentvalves.com	
GEARED MOTOR	Electrical	motor	geared	BONFIGLIOLI		
GEARED MOTOR	Electrical	motor	geared	IC		
GEARED MOTOR	Electrical	motor	geared	SEW		
GEARED MOTOR	Electrical	motor	geared	PREMIUM		
GEARED MOTOR	Electrical	motor	geared	PBL		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	RASHITRYA ISPAT NIGAM LTD.		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	TISCO		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	JINDAL		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	LLOYDS STEEL		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	TATA		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	ESSAR		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	ISPAT INDUSTRIES		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	SAIL		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	BHUSHAN STEELS		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	JSW STEEL		
GI SHEETS FOR DUCTING	Mechanical	Sheet	GI	INDIAN IRON & STEEL CO LTD.		
GRILL/DIFFUSER/VOLUME CONTROL DAMPER	Mechanical	Dampener	GRILL/DIFFUSER/VOLUME CONTROL	TSC		
GRILL/DIFFUSER/VOLUME CONTROL DAMPER	Mechanical	Dampener	GRILL/DIFFUSER/VOLUME CONTROL	CARYAIRE		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
GRILL/DIFFUSER/VOLUME CONTROL DAMPER	Mechanical	Dampener	GRILL/DIFFUSER/VOLUME CONTROL	RAVI STAR (SYSTEM AIR)		
GRILL/DIFFUSER/VOLUME CONTROL DAMPER	Mechanical	Dampener	GRILL/DIFFUSER/VOLUME CONTROL	AIR FLOW		
GRILL/DIFFUSER/VOLUME CONTROL DAMPER	Mechanical	Dampener	GRILL/DIFFUSER/VOLUME CONTROL	AIR MASTER		
GUN METAL VALVES	Mechanical	Valve	GATE/GLOBE -GM	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	
GUN METAL VALVES	Mechanical	Valve	GATE/GLOBE -GM	SANT VALVES		
GUN METAL VALVES	Mechanical	Valve	GATE/GLOBE -GM	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
GUN METAL VALVES	Mechanical	Valve	Gun Metal	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
GUN METAL VALVES	Mechanical	Valve	GATE/GLOBE -GM	VALTECH INDUSTRY	B-5 , NEW SONAL IND.ESTATE SAKI VIHAR ROAD MUMBAI Phone- Pincode : 400072 Email : farooq@valtechindustries.com	
GUN METAL VALVES	Mechanical	Valve	Gun Metal	VALTECH INDUSTRIES	B-5 , NEW SONAL IND.ESTATE SAKI VIHAR ROAD MUMBAI Phone- Pincode : 400072 Email : farooq@valtechindustries.com	GUN METAL SCREWED END TYPE , SCREWED IN BONNET , OUT SIDE SCREW & YOKE TPE , PN 16 , SIZES UPTO 50.
GUN METAL VALVES	Mechanical	Valve	Gun Metal	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	
GUN METAL VALVES	Mechanical	Valve	GATE/GLOBE -GM	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	
GUN METAL VALVES	Mechanical	Valve	Gun Metal	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	
HOOTERS	Electronics	Hooter		BEACON		
HOOTERS	Electronics	Hooter		KHERAJ		
HOOTERS	Electronics	Hooter		TARGET		
HOOTERS	Electronics	Hooter		OSC		
HUMID STAT	Electronics	Instrument	Humidty	JHONSON CONTROL		
HUMID STAT	Electronics	Instrument	Humidty	PENN		
HUMID STAT	Electronics	Instrument	Humidty	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
HVAC FOR FGD	Package			ROOTS COOLING SYSTEMS PVT. LTD.	Mr. Pradeep Choudhary B-53,HOSIERY COMPLEX, PHASE-II NOIDA Phone- 098109-03848 Pincode : 201305 Email : rcspower@rootsdek.com	
HVAC FOR FGD	Package			VOLTAS LTD.	PUMPS DIVISION, P.O.BOX-72, VOLTAS HOUSE, 19, J.N.HERDIA MARG, BALLARD ESTATE, MUMBAI Phone- 22614715 Pincode : 400038 Email : ljha@voltas.com	
HVAC FOR FGD	Package			INDUSTRIAL PROJECT & PRODUCTS CO.	Mr. Surinder Singh, Plot No. 61, Block-7 Ward No.1,behind gyandeep school, Near sector-5 Gurgaon Phone- 8510044695 Pincode : 122001 Email : industrialppc.1@gmail.com	
HVAC FOR FGD	Package			STERLING AND WILSON PRIVATE LIMITED	PREMISES NO. GN-31, 2nd & 3rd FLOOR, SECTOR-5, SALT LAKE, KOLKATA-700091, KOLKATA, Phone- 9007042713 Pincode : 700091 Email : Swarup.mukherjee@sterlingwilson.com	
HVAC FOR FGD	Package			ADVANCE VENTILATION PVT.LTD.	SUMIT CHAUDHARY, 610, PP Towers, C1,2&3 PP Towers, Netaji Subhash Place, Pitampura, New Delhi, Phone- 0130-2219092-96, Pincode : 110034, Email : sales@advanceventilation.com,	
IDCT	Mechanical			NATIONAL BUILDINGS CONSTRUCTION CORPORATION LTD.	Phone- Pincode : Email : bd.nbcc@nic.in	
IDCT	Mechanical			GAMMON INDIA LTD.	GAMMON HOUSE, VEER SAVARKAR MARG, P.O.BOX NO.9129, PRABHADEVI, MUMBAI Phone- 24306761,56614000 Pincode : 400025 Email : gammon@vsnl.com	
IDCT	Mechanical			HAMON SHRIRAM COTTRELL PVT. LTD.,	Main Frame,3A-8A, Ground Floor, Royal Plams Complex,Near Aarey Milk Col. Goregaon (E), Mumbai Phone- 09920751407, Pincode : 400065 Email : abhijit.bagde@hamon.com,	
IDCT	Mechanical			PAHARPUR COOLING TOWERS LTD.	PAHARPUR HOUSE, 8/1/B, DIAMOND HARBOUR ROAD, KOLKATA Phone- 24792050, 24791976 Pincode : 700027 Email : bk.shayani@paharpur.com	
IDCT	Mechanical			PALTECH COOLING TOWERS & EQUIPMENTS LIMITED	Mr. H.P. Yadav B-604 ,Sushant Lok ,Phase-1, Gurgaon Phone- 0124-4499700 Pincode : 122002 Email : paltech@paltech.net.in	
INDICATING LAMPS	Electronics	panel	Lamp	TECKNIC		
INDICATING LAMPS	Electronics	panel	Lamp	BCH		
INDICATING LAMPS	Electronics	panel	Lamp	SIEMENS		
INDICATING LAMPS	Electronics	panel	Lamp	STANDARD		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	CGL		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	NGEF (up to 15KW)		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	JYOTI		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	KEC		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	BHARAT BIJLI		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	MARATHON		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	MARATHON		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	KIRLOSKAR		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	BHARAT BIJLEE		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	CROMPTON		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	SIEMENS		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	NGEF		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	LHP		
INDUCTION MOTORS (LT)	Electrical	Motor	Induction LT	BHARAT ELECTRIC		
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com	
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	Comfit & Valve Pvt. Ltd	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	Perfect Instrumentation Control (India) Pvt. Ltd		
INSTRUMENT FITTINGS	Electronics	fittings	instruments	Comfit & Valve Pvt. Ltd	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com	
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	HP VALVES & FITTINGS INDIA PVT. LTD		
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	Perfect Instrumentation Control (India) Pvt. Ltd		
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
INSTRUMENT FITTINGS	Electronics	fittings	instruments	Arya Crafts & Engineering Pvt. Ltd	Mr. Shridhar G Hegde,P 46,Eighth Avenue, Anjur Village,Main Gate Road, Mahindra World City, Chengalpattu Chennai Phone- 044 3747 4444 Pincode : 603004 Email : shegde@armstronginternational.in	
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	Astec Valves & Fittings Pvt. Ltd		
INSTRUMENT FITTINGS	Electronics	fittings	instruments	Astec Valves & Fittings Pvt. Ltd		
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	Arya Crafts & Engineering Pvt. Ltd	Mr. Shridhar G Hegde,P 46,Eighth Avenue, Anjur Village,Main Gate Road, Mahindra World City, Chengalpattu Chennai Phone- 044 3747 4444 Pincode : 603004 Email : shegde@armstronginternational.in	
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	Panam Engineers		
INSTRUMENT FITTINGS	Electronics	fittings	instruments	Panam Engineers		
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	
INSTRUMENT FITTINGS	Mechanical	Fittings	Instrument	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	
INSTRUMENT FITTINGS	Electronics	fittings	instruments	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	
INSTRUMENT FITTINGS	Electronics	Fittings	instrment	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com	
INSTRUMENTS PIPE FITTINGS	Electronics	Fittings	pipe	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
INSTRUMENTS PIPE FITTINGS	Electronics	Fittings	pipe	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	
INSTRUMENTS PIPE FITTINGS	Electronics	Fittings	pipe	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	
INSTRUMENTS PIPE FITTINGS	Electronics	Fittings	pipe	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	
INSTRUMENTS TUBE FITTINGS	Electronics	Fittings	Tube	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	
INSTRUMENTS TUBE FITTINGS	Electronics	Fittings	Tube	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	
INSTRUMENTS TUBE FITTINGS	Electronics	Fittings	Tube	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	
INSTRUMENTS TUBE FITTINGS	Electronics	Fittings	Tube	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
INSULATING MATS	Electrical			Vardhman Hoses (P) Ltd.	Mr. Mayank Jain/Mr. Abhishek Mallick E-1249, Phase-I, RIICO Indl. Area, Bhiwadi Phone- 9873005253 Pincode : 301 019 Email : info@rubberindia.in	
INSULATING MATS	Electrical			RMG POLYVINYL INDIA LIMITED	MR. UMESH AGGARWAL/MR. HARISH K. BUTIAN 302 ELITE HOUSE36 COMMUNITY CENTRE KAILASH COLONYEXTN. ZAMRUDPUR DELHI Phone- 0120-3118802 Pincode : 110048 Email : info@safevolt.in	
INSULATING MATS	Electrical			V.R. ENTERPRISES	F-5, SITE NO-1, BULANDSHAHR ROAD INDUSTRIAL AREA, GHAZIABAD Phone- 9011037200 Pincode : Email : rohitgupta123in@yahoo.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
INSULATING MATS	Electrical			MARVEL VINYLS LTD	Mr. Saksham Chawla G-73, Connaught Circus New Delhi Phone- 011-45306666 Pincode : 110001 Email : saksham.chawla@marvelvinyls.com	
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	UP TWIGA		
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	PARAMONT		
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	AEROCELL		
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	K-FLEX		
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	LLOYD INSULATIONS (INDIA) LTD.	NP PURI 2, INDUSTRIAL AREA, KALKAJI, PO BOX-4321, NEW DELHI Phone- 9313217704 Pincode : 110019 Email : ak.luthra@lloydinsulation.com	
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	BEARDSHELL		
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	SUPREME		
INSULTATION MATERIAL (Fibreglass / EPS/ PUF / Nitrile /EPDM)	Mechanical	Insulation	(Fibreglass / EPS/ PUF / Nitrile /EPDM)	ARMAFLEX		
JUNCTION BOX	Electronics	Box	Junction	SUCHITRA INDUSTRIES		
JUNCTION BOX	Electronics	Box	Junction	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALOREPhone- Pincode : Email : suchitra.industriesblr@gmail.com	
JUNCTION BOX	Electronics	Box	Junction	FLEXPRO ELECTRICALS PVT. LTD	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com	
JUNCTION BOX	Electronics	Box	Junction	FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com	Metal type junction box only
JUNCTION BOX	Electronics	Box	Junction	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, jmajmera@yahoo.com	
JUNCTION BOX	Electronics	Box	Junction	K.S.INSTRUMENTS PVT.LTD		
JUNCTION BOX	Electronics	Box	Junction	K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net	
JUNCTION BOX	Electronics	Box	Junction	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com	
JUNCTION BOX	Electronics	Box	Junction	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, jmajmera@yahoo.com	
JUNCTION BOX	Electronics	Box	Junction	Shrenik & Company	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	TECHNOMATIC		
LEVEL GAUGE	Electronics	Instrument	Gauge Level	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	TELACO		
LEVEL GAUGE	Electronics	Instrument	Gauge Level	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
LEVEL GAUGE	Electronics	INSTRUMENTS	Gauge Level	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	MAKE:NIVO CONTROLS
LEVEL GAUGE	Electronics	INSTRUMENTS	Gauge Level	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
LEVEL GAUGE	Electronics	Instrument	Gauge Level	AUTOMAT MUMBAI		
LEVEL GAUGE	Electronics	Instrument	Gauge Level	D.K. INSTRUMENTS PVT.LTD.	N.SIKDAR/ SUMIT SIKDAR 76/2,SELIMPUR RD DHAKURIA Kolkata Phone- 033-2415-1310. Pincode : 700031 Email : dkinst@vsnl.net	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	CHEMTROLS	AMAR HILL, SAKI VIHAR ROAD, POWAI, MUMBAI Phone- 022-28575089 Pincode : 400021 Email : manikandan@chemtrols.co.in	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
LEVEL GAUGE	Electronics	Instrument	Gauge Level	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
LEVEL GAUGE	Electronics	INSTRUMENTS	Gauge Level	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	
LEVEL SWITCH	Electronics	Instrument	Switch level	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
LEVEL SWITCH	Electronics	Instrument	Switch level	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	
LEVEL SWITCH	Electronics	Instrument	Switch level	RAMAN INST		
LEVEL SWITCH	Electronics	Instrument	Switch level	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
LEVEL SWITCH	Electronics	Instrument	Switch level	NIVO CONTROLS		
LEVEL SWITCH	Electronics	Instrument	Switch level	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
LEVEL SWITCH	Electronics	Instrument	Switch level	WAREE INST		
LEVEL SWITCH	Electronics	Instrument	Switch level	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	
LEVEL SWITCH	Electronics	Instrument	Switch level	DK INSTURMENT		
LEVEL SWITCH	Electronics	Instrument	Switch level	SAPCON INSTRUMENT		
LEVEL SWITCH	Electronics	Instrument	Switch level	CHEMTROLS	AMAR HILL, SAKI VIHAR ROAD, POWAI, MUMBAI Phone- 022-28575089 Pincode : 400021 Email : manikandan@chemtrols.co.in	
LEVEL SWITCH	Electronics	Instrument	Switch level	GIC		
LEVEL SWITCH	Electronics	Instrument	Switch level	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	
LEVEL SWITCH	Electronics	Instrument	Switch level	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
LEVEL SWITCH	Electronics	Instrument	Switch level	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
LEVEL SWITCH	Electronics	Instrument	Switch level	TRAC		
LEVEL SWITCH	Electronics	Instrument	Switch level	FLOW TECH		
LEVEL SWITCH	Electronics	Instrument	Switch level	SIEMENS		
LEVEL SWITCH	Electronics	Instrument	Switch level	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
LEVEL SWITCH	Electronics	Instrument	Switch level	HI TECH		
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
LEVEL SWITCH-CAPACITANCE TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	Sapcon Instrument Pvt Ltd.	131, PALSHIKAR COLONYContact Person- Mr. Ashwin (9826080207) INDORE Phone- +91-731-4085751, Pincode : 452004 Email : sales@sapconinstruments.com	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	RAMAN INSTRUMENTS PVT.LTD.	Mr. N R Shenoy/Mr G B Vijh 8, First Floor.Plot : 160A Bait-Ush-Sharaf, 29th Road,Bandra(W) MUMBAI Phone- 09892331381 Pincode : 400050 Email : ramanbpl@vsnl.com	Vendor shall source import contents of Level Switch (Conductivity Type) from Mobrey Measurement, an operating unit of Morbey Ltd., Slough, Berkshire, United Kingdom.
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	
LEVEL SWITCH-CONDUTIVITY TYPE	Electronics	INSTRUMENTS	Switch level Capacitance	HI-TECH SYSTEMS & SERVICES LTD.	Mr. Vikash Agrawal/Mr. Tarun Debnath 119, PARK STREET , KOLKATA Phone- 033-22290045 Pincode : 700016 Email : sandeep@hitech.in	Vendor shall source import contents of Level Switch (Conductivity Type) from Levelstate Systems Ltd., United Kingdom.
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	D.K. INSTRUMENTS PVT.LTD.	N.SIKDAR/ SUMIT SIKDAR 76/2,SELIMPUR RD DHAKURIA Kolkata Phone- 033-2415-1310. Pincode : 700031 Email : dkinst@vsnl.net	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
LEVEL SWITCH-FLOAT TYPE	Electronics	INSTRUMENTS	Switch level Float	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
LEVEL TRANSMITTER	Electronics	Transmitter	LEVEL	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
LIMIT SWITCHES	Electronics	Switch	Limit	SPEED-O-CONTROL		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
LIMIT SWITCHES	Electronics	Switch	Limit	ELECTROMAG		
LOCAL CONTROL PANELS	Electrical	Panel	Local Control	C and S ELECTRIC LTD.	222, OKHLA INDUSTRIAL ESTATE, PHASE-II, NEW DELHI Phone- 9871799447 Pincode : 110020 Email : panel.marketing@cselectric.co.in	
LOCAL CONTROL PANELS	Electrical	Panel	Local Control	INDUSTRIAL CONTROLS & APPLIANCES PVT LTD	47, CHAKALA ROAD, ANDHERI(EAST), MUMBAI Phone- 28344494,28221532 Pincode : 400099 Email : indconapp@vsnl.com	
LOCAL CONTROL PANELS	Electrical	Panel	Local Control	PYROTECH ELECTRONICS PVT. LTD.	Unit-IV, A-193, M.I.A. Dadri, UDAIPUR Phone- 2492122,31,34 Pincode : 313003 Email : pyrotech@pyrotechindia.com	
LOCAL CONTROL PANELS	Electrical	Panel	Local Control	PROCON INSTRUMENTATION PVT. LTD.	1H, SHAKTI TOWERS, 766, ANNA SALAI, CHENNAI Phone- 28266041,2824142 Pincode : 600022 Email : procond1@nda.vsnl.net.in	
MAGNETIC FLOW METER	Electronics	Transmitter	FLOW	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
MCB	Electronics	Breaker	MCB	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	WILO MATHER & PLATT PUMPS PVT. LTD.	MUMBAI-PUNE ROAD, CHINCHWAD, PUNE Phone- 27442100/1/2/3/4 Pincode : 411019 Email : vmattoo@pun.matherplatt.co.in	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	BHARAT PUMPS & COMPRESSORS LTD	NAINI, ALLAHABAD (UP) ALLAHABAD Phone- 0532 2697412-15 Pincode : 211 010 Email : siraj.ahmad@bharatpumps.co.in	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	MAXFLOW PUMPS INDIA PVT. LTD.	Mr. Chirag Agarwal PLOT NO. 306 307, Sector 7 II, IMT MANESAR, GURUGRAM Phone- 0124-4525000 Pincode : 122050 Email : sales@maxflowpumps.com; rnt@maxflowpumps.com	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	V-Flo Pumps & Systems Co. Ltd.,	5th Floor East, Jiahuiyuan, Huaao Center 31 Zizhuyuan Rd., Beijing Phone- 0086-10-51906628 Pincode : 100089 Email : sales@v-flo.com	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	SINTECH PRECISION PRODUCT LTD.	Ms. Akansha Sharma C-189 & 190, B.S. ROAD INDUSTRIAL AREA SITE NO.1, GHAZIABAD Phone- 0120-4176000 Pincode : 201001 Email : sahil@sintechpumps.com	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	FLOWMORE LTD.	443, UDYOG VIHAR, PH-III GURGAON-122016 HARYANA Phone- 01243010892 Pincode : 122016 Email : ps@flowmoregroup.com; corporate@flowmoregroup.com	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	WPIL LIMITED	Trinity Plaza, 84/1A, Topsia Road (South), Kolkata- 700046 KOLKATA Phone- Pincode : 700046 Email : bs@wpil.co.in; nrosales@wpil.co.in	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	VARAT PUMP AND MACHINERY PVT. LTD.	Mr. Kishore Kumar Bose 20, Netaji Subhas Road Kolkata Phone- 9230504569 Pincode : 700001 Email : sinha3227@gmail.com	
MISC. PUMPS(HORZ.) TYPE-I (FLOW<300 CMH)	Mechanical	Pump	Centrifugal horizontal	KIRLOSKAR BROTHERS LTD.	KIRLOSKAR PRESS COMPOUND, UDYOG BHAWAN,TILAK ROAD, PUNE Phone- 2447550,240672 Pincode : 411002 Email : kblin@kbl.co.in; gosain@del.kbl.co.in	
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	V-Flo Pumps & Systems Co. Ltd.,	5th Floor East, Jiahuiyuan, Huaao Center 31 Zizhuyuan Rd., Beijing Phone- 0086-10-51906628 Pincode : 100089 Email : sales@v-flo.com	
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	FLOWMORE LTD.	443, UDYOG VIHAR, PH-III GURGAON-122016 HARYANA Phone- 01243010892 Pincode : 122016 Email : ps@flowmoregroup.com; corporate@flowmoregroup.com	
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	VARAT PUMP AND MACHINERY PVT. LTD.	Mr. Kishore Kumar Bose 20, Netaji Subhas Road Kolkata Phone- 9230504569 Pincode : 700001 Email : sinha3227@gmail.com	Flow upto 700 Cub M/Hr
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	BHARAT PUMPS & COMPRESSORS LTD	NAINI, ALLAHABAD (UP) ALLAHABAD Phone- 0532 2697412-15 Pincode : 211 010 Email : siraj.ahmad@bharatpumps.co.in	
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	WPIL LIMITED	Trinity Plaza, 84/1A, Topsia Road (South), Kolkata- 700046 KOLKATA Phone- Pincode : 700046 Email : bs@wpil.co.in; nrosales@wpil.co.in	
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	SINTECH PRECISION PRODUCT LTD.	Ms. Akansha Sharma C-189 & 190, B.S. ROAD INDUSTRIAL AREA SITE NO.1, GHAZIABAD Phone- 0120-4176000 Pincode : 201001 Email : sahil@sintechpumps.com	Flow upto 1600 Cub. M/Hr
MISC. PUMPS(HORZ.) TYPE-II(FLOW>300 CMH)	Mechanical	Pump	Centrifugal horizontal	MAXFLOW PUMPS INDIA PVT. LTD.	Mr. Chirag Agarwal PLOT NO. 306 307, Sector 7 II, IMT MANESAR, GURUGRAM Phone- 0124-4525000 Pincode : 122050 Email : sales@maxflowpumps.com; rnt@maxflowpumps.com	Upto 1600 CuM/Hr
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	SINTECH PRECISION PRODUCT LTD.	Ms. Akansha Sharma C-189 & 190, B.S. ROAD INDUSTRIAL AREA SITE NO.1, GHAZIABAD Phone- 0120-4176000 Pincode : 201001 Email : sahil@sintechpumps.com	Flow upto 1600 Cub. M/Hr
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	FLOWMORE LTD.	443, UDYOG VIHAR, PH-III GURGAON-122016 HARYANA Phone- 01243010892 Pincode : 122016 Email : ps@flowmoregroup.com; corporate@flowmoregroup.com	
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	V-Flo Pumps & Systems Co. Ltd.,	5th Floor East, Jiahuiyuan, Huaao Center 31 Zizhuyuan Rd., Beijing Phone- 0086-10-51906628 Pincode : 100089 Email : sales@v-flo.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	KIRLOSKAR BROTHERS LTD.	KIRLOSKAR PRESS COMPOUND, UDYOG BHAWAN,TILAK ROAD, PUNE Phone- 2447550,240672 Pincode : 411002 Email : kblin@kbl.co.in; gosain@del.kbl.co.in	
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal Vertical	VARAT PUMP AND MACHINERY PVT. LTD.	Mr. Kishore Kumar Bose 20, Netaji Subhas Road Kolkata Phone- 9230504569 Pincode : 700001 Email : sinha3227@gmail.com	Flow upto 700 Cub M/Hr
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	MAXFLOW PUMPS INDIA PVT. LTD.	Mr. Chirag Agarwal PLOT NO. 306 307, Sector 7 II, IMT MANESAR, GURUGRAM Phone- 0124-4525000 Pincode : 122050 Email : sales@maxflowpumps.com; rnt@maxflowpumps.com	Upto 1600 CuM/Hr
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	WPIL LIMITED	Trinity Plaza, 84/1A, Topsia Road (South), Kolkata-700046 KOLKATA Phone- Pincode : 700046 Email : bs@wpil.co.in; nrosales@wpil.co.in	
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	WILO MATHER & PLATT PUMPS PVT. LTD.	MUMBAI-PUNE ROAD, CHINCHWAD, PUNE Phone- 27442100/1/2/3/4 Pincode : 411019 Email : vmattoo@pun.matherplatt.co.in	
MISC.PUMPS (HORIZONTAL)	Mechanical	Pump	Centrifugal horizontal	BHARAT PUMPS & COMPRESSORS LTD	NAINI, ALLAHABAD (UP) ALLAHABAD Phone- 0532 2697412-15 Pincode : 211 010 Email : siraj.ahmad@bharatpumps.co.in	
MISC.PUMPS (VERTICAL)	Mechanical	Pump	Centrifugal Vertical	WILO MATHER & PLATT PUMPS PVT. LTD.	MUMBAI-PUNE ROAD, CHINCHWAD, PUNE Phone- 27442100/1/2/3/4 Pincode : 411019 Email : vmattoo@pun.matherplatt.co.in	
MISC.PUMPS (VERTICAL)	Mechanical	Pump	Centrifugal Vertical	FLOWMORE LTD.	443, UDYOG VIHAR, PH-III GURGAON-122016 HARYANA Phone- 01243010892 Pincode : 122016 Email : ps@flowmoregroup.com; corporate@flowmoregroup.com	NO LIMIT SINCE 24.05.2012
MISC.PUMPS (VERTICAL)	Mechanical	Pump	Centrifugal Vertical	BHARAT PUMPS & COMPRESSORS LTD	NAINI, ALLAHABAD (UP) ALLAHABAD Phone- 0532 2697412-15 Pincode : 211 010 Email : siraj.ahmad@bharatpumps.co.in	
VALVE	Mechanical	Valve	Motorized	FLUID LINE		
VALVE	Mechanical	Valve	Motorized	KBL		
VALVE	Mechanical	Valve	Motorized	ANERGY		
VALVE	Mechanical	Valve	Motorized	BELIMO		
VALVE	Mechanical	Valve	Motorized	BANKIM & COMPANY		
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	H.SARKER and COMPANY	13, CROOKED LANE, HOWRAH Phone- 9163692218 Pincode : 711113 Email : hsblt09@gmail.com ; hs_newdelhi@yahoo.comhsblt09@gmail.com	
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	ADVANCE VALVES PVT. LTD.	B-33, SECTOR-2, NOIDA Phone- + 91 -120 - 4796900 Pincode : 201301 Email : m.shahnawaz@advancevalves.com	
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	SURYA VALVES AND INSTRUMENT MANUFACTURING		
VALVE	Mechanical	Valve	Motorized	JOHNSON		
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
VALVE	Mechanical	Valve	Motorized	GM DAULI & SONS		
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	VENUS PUMPS AND ENGINEERING WORKS	40, STRAND ROAD, Ist FLOOR, KOLKATA Phone- 033-26531546 Pincode : 700001 Email : venus.rajesh68@gmail.com	
MOTORIZED BUTTERFLY VALVE	Mechanical	Valve	Butterfly-Motorized	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
Non Mettalic Pumps				Anticorrosive Equipment Pvt Ltd (ANTICO)	Office: 15 Hind Service Inds, Off VS Marg, Shivaji Park, Mumbai 400028 MH India Ph: +91 22 24453501/24468340	
Non Mettalic Pumps				Engineers Combine	Shop No 215, Avon Arcade, 2nd Floor, D J Road, Vile Parle West, Mumbai - 400056,	
Non Mettalic Pumps				Leak-Proof Pumps (I) Pvt. Ltd.	1 - G, Laxmi Industrial Estate, New Link Road, Andheri (West), Mumbai 400 053, INDIA. Fax: +91-22- 2632 0866 Phone: +91-22-2636 1737, 2639 0337/38 E-mail: rppl@rajediapumps.com sales@rajediapumps.com	
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	H.SARKER and COMPANY	13, CROOKED LANE, HOWRAH Phone- 9163692218 Pincode : 711113 Email : hsblt09@gmail.com ; hs_newdelhi@yahoo.comhsblt09@gmail.com	
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	VENUS PUMPS AND ENGINEERING WORKS	40, STRAND ROAD, Ist FLOOR, KOLKATA Phone- 033-26531546 Pincode : 700001 Email : venus.rajesh68@gmail.com	
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	KBL		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	SHIVADURGA		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	FLUID LINE		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	GM DAULI & SONS		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	HI -TECH		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	BANKIM & COMPANY		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	SURYA VALVES AND INSTRUMENT MANUFACTURING		
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	
NON RETURN VALVE(CI)	Mechanical	Valve	NRV-CI	CRESCENT VALVES MFG CO. PVT. LTD	BLUE HAVEN 15 FAROOQ S UMAR STREET MUMBAI Phone- 02223014026 Pincode : 400011 Email : mehboob@crescentvalves.com	
OVER LOAD RELAYS	electronics	relay	Overload	SCHNEIDER (Earlier TELE MACHANIQUE)		
OVER LOAD RELAYS	electronics	relay	Overload	SIEMENS		
OVER LOAD RELAYS	electronics	relay	Overload	L&T		
OVER LOAD RELAYS	electronics	relay	Overload	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
OWS / PC	Electronics	PC		LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
OWS / PC	Electronics	PC		COMPAQ		
OWS / PC	Electronics	PC		HCL		
OWS / PC	Electronics	PC		HP		
OWS / PC	Electronics	PC		DELL		
OWS / PC	Electronics	PC		IBM		
PACKAGE UNIT	Mechanical	package	AC	CARRIER		
PACKAGE UNIT	Mechanical	package	AC	VOLTAS	Corporate Headquarters Voltas Limited Voltas House 'A' Block Dr. Babasaheb Ambedkar Road Chinchpokli	
PACKAGE UNIT	Mechanical	package	AC	BLUE STAR LIMITED	Jamshedji Tata Road, Mumbai - 400 020 Phone: (91) (22) 6665 4000 Fax: (91) (22) 6665 4151 www.bluestarindia.com	
PAINT	Mechanical	Paint	Steel	Hemple Paints (Singapore)		
PAINT	Mechanical	Paint	Steel	Bombay Paints		
PAINT	Mechanical	Paint	Steel	Jenson & Nicholson (I) Ltd		
PAINT	Mechanical	Paint	Steel	Asian Paints (I) Ltd		
PAINT	Mechanical	Paint	Steel	Jotun Paints		
PAINT	Mechanical	Paint	Steel	Grand Polycoat		
PAINT	Mechanical	Paint	Steel	CDC carboline (I) Ltd		
PAINT	Mechanical	Paint	Steel	Goodlass Nerolac		
PAINT	paint			Jotun India Private Limited	Fulcrum, A wing - 601(II)/602, Next to Hyatt Regency, Sahar Road Andheri (E), Mumbai - 400099 +91 22 26848932,+91 226787 2100 jotun.mumbai@jotun.com	
PAINT	Mechanical	Paint	Steel	Addison Paints Ltd		
PAINT	Mechanical	Paint	Steel	Berger Paints India Ltd		
PAINT	Mechanical	Paint	Steel	Shalimar Paints Ltd		
PAN HUMIDIFIER	Mechanical	Humidifier	PAN	RAPID COOL		
PAN HUMIDIFIER	Mechanical	Humidifier	PAN	ALCO		
PAN HUMIDIFIER	Mechanical	Humidifier	PAN	HOTSET		
PIPING – CS SEAMLESS (ASTM A 106)	Mechanical	pipe	CS Seamless	MAHARASHTRA SEAMLESS		
PIPING – CS SEAMLESS (ASTM A 106)	Mechanical	pipe	CS Seamless	ISMT		
PIPING - ERW	Mechanical	Pipe	ERW	INDUS TUBE		
PIPING - ERW	Mechanical	Pipe	ERW	SAIL		
PIPING - ERW	Mechanical	Pipe	ERW	TATA TUBES		
PIPING - ERW	Mechanical	Pipe	ERW	LALIT PROFILE		
PIPING - ERW	Mechanical	Pipe	ERW	TISCO		
PIPING - ERW	Mechanical	Pipe	ERW	BST		
PIPING - ERW	Mechanical	Pipe	ERW	HITECH PIPES		
PIPING - ERW	Mechanical	Pipe	ERW	DADU PIPES		
PIPING - ERW	Mechanical	Pipe	ERW	MAHARASHTRA SEAMLESS		
PIPING - ERW	Mechanical	Pipe	ERW	GOODLUCK TUBES		
PIPING - ERW	Mechanical	Pipe	ERW	MANN INDUSTRIES		
PIPING - ERW	Mechanical	Pipe	ERW	MUKUT PIPES		
PIPING - ERW	Mechanical	Pipe	ERW	JINDAL		
PIPING - ERW	Mechanical	Pipe	ERW	RATNAMANI		
PIPING - ERW	Mechanical	Pipe	ERW	PSL		
PIPING - ERW	Mechanical	Pipe	ERW	JCO GAS PIPES		
PIPING - ERW	Mechanical	Pipe	ERW	SURYA ROSHNI		
PIPING - ERW	Mechanical	Pipe	ERW	PRATIBHA PIPES AND STRUCTURES PVT LTD		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
PIPING - ERW	Mechanical	Pipe	ERW	SURENDRA ENGINEERING		
PIPING - ERW	Mechanical	Pipe	ERW	WELSPUN		
PIPING - ERW	Mechanical	Pipe	ERW	SAMSHI PIPE INDUSTRIES		
PIPING - ERW	Mechanical	Pipe	ERW	NUKAT TANK AND VESSELS		
PIPING - ERW	Mechanical	Pipe	ERW	BIHAR TUBES		
PIPING - ERW	Mechanical	Pipe	ERW	ADVANCE STEEL TUBES		
PLC BASED PANEL	Electronics	PLC		Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
PLC BASED PANEL	Electronics	PLC		MITSUBISHI ELECTRIC		
PLC BASED PANEL	Electronics	PLC		SCHENIEDER		
PLC BASED PANEL	Electronics	PLC		GE Intelligent Platforms Private Limited	90/B, ELECTRONICS CITY, HOSUR ROAD, BANGLORE Phone- 28528328 Pincode : 561229 Email : shivesh.k.jha@ge.com	
PLC BASED PANEL	Electronics	PLC		ROCKWELL AUTOMATION INDIA LTD	(ALLENBRADLEY),C-11, SITE-4, INDUSTRIAL AREA SHHIBABAD, GHAZIABAD Phone- 2895247-52 Pincode : 201010 Email : pmehrotra@rockwell.com	
PLC BASED PANEL	Electronics	PLC		SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
PLC BASED PANEL	Electronics	PLC		ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
PLUG VALVES	Mechanical	Valve	Plug	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	147, KARAPAKKAM VILLAGE, CHENNAI Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	CL.150 NB 450 , CL. 300 NB 400, NB,CL. 600 NB 150, MATL. CCS, SH A216 GR WCB AND CSS, SH A351 GR. CF8M
PLUG VALVES	Mechanical	Valve	Plug	WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	DLF Tower-B, Unit No: 1212, 1214 & 1215, 12th Floor, Jasola District Centre, Sarita Vihar, New Delhi - 110044 NEW DELHI Phone- 011-40503345/ 46/ 47 Pincode : 110044 Email : Brijesh.Manchanda@mail.weir	
PLUG VALVES	Mechanical	Valve	Plug	LARSEN and TOUBRO LTD.	Mr. Mohan Kumar L & T HOUSE, BALLARD ESTATE, P.O.BOX-278, MUMBAI Phone- 22618181/82 Pincode : 400001 Email : BAS@LNTECC.COM	
PNEUMATIC ACTUATOR/ CYLINDER (UP TO 12"	Mechanical	Actuator		SCHARDER		
PNEUMATIC ACTUATOR/ CYLINDER (UP TO 12"	Mechanical	Actuator		ROTEX		
PNEUMATIC ACTUATOR/ CYLINDER (UP TO 12"	Mechanical	Actuator		VASS		
PNEUMATIC ACTUATOR/ CYLINDER (UP TO 12"	Mechanical	Actuator		NUCON		
PRECISION PACKAGE UNITS	Mechanical	package	AC	STULZ		
PRECISION PACKAGE UNITS	Mechanical	package	AC	CLIMADENTA		
PRECISION PACKAGE UNITS	Mechanical	package	AC	BLUEBOX		
PRECISION PACKAGE UNITS	Mechanical	package	AC	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com	
PRECISION PACKAGE UNITS	Mechanical	package	AC	UNIFLAIR		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	Instrument	Gauge Pressure Diff Pressure	WIKA		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	MANOMETER INDIA		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	LEVCON	Levcon Instrument Pvt. Ltd. S Gupta(Managing Director) No. 138 F Road, Picnic Garden, Bali Ganj Ciljala Post Office, Picnic Garden, Kolkata - 700039, West Bengal, India +91-9831826893	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	SIGMA		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	D K INSTRUMENTS		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	Instrument	Gauge Pressure Diff Pressure	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	BARTON INST. SYSTEM		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	BUDENBERG GUAGE CO.LTD.		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	TRAFAG		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	Instrument	Gauge Pressure Diff Pressure	GLUCK INDIA		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gauge Pressure Diff Pressure	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	INDFOSS		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	Instrument	Gauge Pressure Diff Pressure	WAAREE INSTRUMENTS		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	SWITZER (DP GAUGE)		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	AUXITROL		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	Instrument	Gauge Pressure Diff Pressure	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	DRESSER		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	SBEM, PUNE		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	PUNE TECHTROL		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	Instrument	Gauge Pressure Diff Pressure	ASHCROFT INDIA PVT LTD.		
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Electronics	INSTRUMENTS	Gasuge Pressure	GOA THERMOSTATIC		
Pressure Relief Valve	Mechanical	VALVE	PRV	SELF MANUFACTURED		
PRESSURE RELIEF VALVE	Mechanical	RELIEF VALVE		SUPPLIERS/SUB-VENDORS		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	VASU		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	MITTAL REFRIGERATION		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	Barksdale GmbH, Germany	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	BARKSDALE GMBH		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	DANFOSS		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	DELTA CONTROL		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	Kaustubha Udyog,	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune, Phone- 020-24393577, Pincode : Email : pressure@vsnl.com,	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	KASTURBA UDYOG		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	BELLS CONTROLS LTD		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	DK INSTRUMENTS		
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	INSTRUMENTS	PRESSURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	ASHCROFT INDIA PVT LTD.		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Electronics	Instrument	Switch P DP	TRAFAG		
PRESSURE VESSELS	MECHANICAL	VESSELS	PRESSURE	S. V. Fabricators	S. V. Fabricators Satish Thakor(Proprietor) No. 856/9- E, GIDC Estate, Makarpura, Makarpura Gidc, Vadodara - 390010, Gujarat, InDIA Call Us: +91-9726716894 Send SMS	
PRESSURE VESSELS	Mechanical	VESSELS	PRESSURE	Murthal Tanks & Vessels	50 K.M Stone(Link Road Kurar) G.T. Road, Murthal, Sonipat 131001 Haryana, India Phone 1: +91 9812003117 Phone 2: +91 9991410000 Phone 3: +91 8254900009 info@murthaltanks.com mtv_murthal@yahoo.co.in	
PRESSURE VESSELS	mechanical	VESSELS	PRESSURE	Rishi Industries	Address :40 L M Stone,GT Road Sonepat, Bahalgarh Road, Bahalgarh, Sonipat - 131001 , Haryana , India Contact Person :Mr. S D Bhutani (Proprietor) Phone :91-130-2381202 Mobile :+919992555844 State:Haryana Phone:91-1264-282801 Fax:91-1264-282899	
PRESSURE VESSELS	Mechanical	VESSELS	PRESSURE	Universal Heat Exchangers Ltd	Plant - I Pollachi Road Malumachampatti Post Coimbatore- 641021, India Phone - +91-(422)-2610835, 2610836 Fax - +91-(422)-2610746 Email - marketing@uniheat.com	
PRESSURE VESSELS	MECHANICAL	VESSELS	PRESSURE	Jasmino Polymertech Pvt Ltd	Jasmino Polymertech Pvt Ltd M.Perumal (Manager) L ¿¿¿ 61, MIDC Taloja, MIDC Taloja, Raigad - 410208, Maharashtra, India Call Us: +91-9821948287	
PRESSURE VESSELS	Mechanical	Vessels	PRESSURE	ATS CHEM EQUIPMENTS PVT LTD	Unit - I, C - 27, SIDCO Industrial Estate, Hosur - 635 126, Tamil Nadu, India. Phone : 04344 - 276731 MR. S.THANGARAJ Managing Director Contact No : +91 - 9443378152 Mr. S.Arumugam Director Contact No : Contact No : +91 - 9443376731 Mr. H.M.Ammar Dire	
PRESSURE VESSELS	MECHANICAL	VESSELS	PRESSURE	SYSCON ENGINEERS	Contact Person : Mr. C. A. Benadikar 207, Dhanlaxmi Service Industrial Estate, Above Navneet Motors, L. B. S. Marg, Thane (W) - 400 601. Maharashtra (INDIA) Tel. No. : +91-22-2172 1108, 4088 Telefax No. : +91-22-2172 1497 E-mail :head	
PRESSURE VESSELS	MECHANICAL	VESSELS	PRESSURE	SPARK ENGINEERS	Address: 'J' Block, Plot No. 429, MIDC, Bhosari, Pune - 411 026 Ph:(020) 46768504 / 66113897Telefax:(020) 27130510 / 66113897 Email:info@sparkengineers.co.in	
PRESSURE VESSELS	MECHANICAL	VESSELS	PRESSURE	The Anup Engineering Limited	The Anup Engineering Limited Soni ni chali, G I D C Industrial Area, Odhav, Ahmedabad, Gujarat 382350 Telephone +91-79-2287 0622 +91-79-4025 8900 Fax +91-79-2287 0642 Sales Related marketing@anupengg.com Procurement procurement@anupengg.com	
PRESSURE VESSELS	mechanical	VESSELS	PRESSURE	Progen Systems & Technologies Limited	Add Photo Apollo Computer Education LtdHB EDUCATION AND CONSULTING SERVICES PVT LTDHB EDUCATION AND CONSULTING Triton Square, 1st Floor, Skcl Building, Unit No: C3 To C7, Thiru Vl Ka Industrial Estate, Guindy, C, Guindy, Chennai - 600032 (Map)	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
PRESSURE VESSELS	mechanical	VESSELS	PRESSURE	Crystal Engineering Systems Pvt.Ltd.	Survey No:1186/2A & 2B Opp. to FIEM Industries Kelamangalam road Achettipalli (P.O.), HCF (Via) Hosur-635110. Tamilnadu. India. Phone : 91-4344-656053, 656062 Mobile : +91-9443358771/9655218771 Email : enquiry@crystalengineeringsystems.com A. Jay	
PRESSURE VESSELS	Mechanical	VESSELS	PRESSURE	ISHAN EQUIPMENTS PVT. LTD	(UNIT- I) 404 - 405, GIDC Industrial Estate, B/h L&T NIRO, Ranoli - 391 350, Dist Baroda (Gujarat) India +91-0265-2308589 +91-0265-2241217 info@ishanequipments.com	
PRESSURE VESSELS	Mechanical	VESSELS	PRESSURE	Titan Engineering Company Private Limited	Indrajit Sengupta(Manager) No. 2/7, Sarat Bose Road, 5th Floor ., Sarat Bose Road , Kolkata - 700020, West Bengal, India Call Us: +91-9434009032	
PRESSURE VESSELS	mechanical	VESSELS	PRESSURE	Chem Process Systems	15 Natraj Industrial Estate, Sanand-Viramgam Highway, Vasna-Iyava, Sanand - 382 170. Ahmedabad. India.+91 2717 284148- 49+91 2717 284194 chem@chemprosys.com Mr. Sagar Desai HR Manager sagar@chemprosys.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	YOKOGAWA	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	147, KARAPAKKAM VILLAGE, CHENNAI Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	FUJI		
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	MOORE		
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
PRESSURE/ DIFF. PRESSURE TRANSMITTER	Electronics	Transmitter	P DP	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
PRINTER	Electronics	Printer		EPSON		
PRINTER	Electronics	Printer		CANON		
PRINTER	Electronics	Printer		HP		
PRINTER	Electronics	Printer		IBM		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
PRINTER	Electronics	Printer		XEROX	Trinity Plaza, 84/1A, Topsia Road (South), Kolkata-700046 KOLKATA Phone- Pincode : 700046 Email : bs@wpil.co.in; nrosales@wpil.co.in	
PRINTER	Electronics	Printer		LEXMARK		
PROGRAMMABLE LOGIC CONTROLLER	Electronics	PLC		MITSUBISHI ELECTRIC INDIA PVT. LTD.	Mr. Mehul Dholakia Emerald House, EL-3, J Block, M.I.D.C., Bhosari, Pune Phone- 020-27102000 Pincode : 411026 Email : mehul.dholakia@asia.meap.com	
PROGRAMMABLE LOGIC CONTROLLER	Electronics	PLC		Honeywell Automation India Limited ,	56 & 57, Hadapsar Industrial Estate, Pune, Phone-9689940949, Pincode : Email : amit.aglave@honeywell.com,	
PROGRAMMABLE LOGIC CONTROLLER	Electronics	PLC		ROCKWELL AUTOMATION INDIA LTD	(ALLENBRADLEY),C-11, SITE-4, INDUSTRIAL AREA SHHIBABAD, GHAZIABAD Phone- 2895247-52 Pincode : 201010 Email : pmehrotra@rockwell.com	
PROGRAMMABLE LOGIC CONTROLLER	Electronics	PLC		SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
PROGRAMMABLE LOGIC CONTROLLER	Electronics	PLC		GE Intelligent Platforms Private Limited	90/B, ELECTRONICS CITY, HOSUR ROAD, BANGLORE Phone- 28528328 Pincode : 561229 Email : shivesh.k.jha@ge.com	
PROGRAMMABLE LOGIC CONTROLLER	Electronics	PLC		SCHNEIDER ELECTRIC INDIA PVT.LTD.	A-4 , MOHAN CO-OP INDL AREA MATHURA ROAD NEW DELHI Phone- Pincode : 110044 Email : aditya.bawa@schneider-electric.com	
Pumps	Mechanical	Pump	Centrifugal horizontal	KIRLOSKAR BROTHERS LTD.	KIRLOSKAR PRESS COMPOUND, UDYOG BHAWAN,TILAK ROAD, PUNE Phone-2447550,240672 Pincode : 411002 Email : kblin@kbl.co.in; gosain@del.kbl.co.in	
PUSH BUTTONS	Electronics	panel	Push Buttons	SCHNEIDER		
PUSH BUTTONS	Electronics	panel	Push Buttons	BCH		
PUSH BUTTONS	Electronics	panel	Push Buttons	SIEMENS		
PUSH BUTTONS	Electronics	panel	Push Buttons	L&T		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	SPECIAL CABLES PVT. LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	KEC INTERNATIONAL LIMITED		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	ELKAY TELELINKS LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	KRISHNA ELECTRICAL INDUSTRIES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	APAR INDUSTRIES LTD., CMI LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	HAVELLS INDIA LIMITED		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	CORDS CABLE INDUSTRIES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	NICCO CORPORATION LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	MANSFIELD CABLES COMPANY LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	KEI INDUSTRIES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	UNIVERSAL CABLES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	CMI LIMITED		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	CRYSTAL CABLE INDUSTRIES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	RAVIN CABLES LIMITED		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	ADVANCE CABLE TECHNOLOGIES (P) LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	SPM POWER & TELECOM PVT. LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	SUYOG ELECTRICALS LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	INCOM CABLES (P) LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	SCOT INNOVATION WIRES AND CABLES PVT. LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	DIAMOND POWER INFRASTRUCTURE LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	POLYCAB WIRES PVT. LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	SAM CABLES & CONDUCTORS (P) LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	GEMSCAB INDUSTRIES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	THERMO CABLES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	PARAMOUNT COMMUNICATIONS LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	TIRUPATI PLASTOMATICS PVT. LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	GOVIND CABLE INDUSTRIES		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	TORRENT CABLES LTD		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	GUPTA POWER INFRASTRUCTURE LIMITED		
PVC CONTROL CABLES	Electrical	Cable	PVC Control	DELTON CABLES LTD		
PVC WIRES	Electrical			K C POWERTRACKS	Mr. SUDHAKAR GARG (CEO), S. NO. 185/1/1, PLOT NO. 7, DOKMARDI SILVASSA Phone- 02602600031 Pincode : 396230 Email : powertrackscable@gmail.com	
PVC WIRES	Electrical			VICTOR PUSHIN CORDS PVT. LTD.	Mr. Bimal Kumar Sharma, C-10 Site-C, Surajpur Industrial Area, Greater Noida Phone- 0120-2561015 Pincode : 201306 Email : bimal@victorcomponent.co.in	
PVC WIRES	Electrical			CMI LTD.	Mr.Munishvar Gaur, 501-503,New Delhi House, 27,Barakhamba Road New Delhi, Phone-9599599244 Pincode : 110001 Email : mgaur@cmilimited.in	
PVC WIRES	Electrical			ALLIED ENGINEERING WORKS PVT. LTD.	M-11&22, BADLI INDUSTRIAL ESTATE NEW DELHI Phone- 01127850456 Pincode : 110042 Email : goelashutosh@yahoo.com	
PVC WIRES	Electrical			PARAMOUNT COMMUNICATIONS LTD.	Mr. Sanjay Aggarwal C-125, Naraina Industrial Area, Phase-I, NEW DELHI Phone- 9650005915 Pincode : 110028 Email : jatan.singh@paramountcables.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
PVC WIRES	Electrical			POLYCAB INDIA LIMITED	HICO HOUSE, Ist FLOOR, 771, PANDIT SATWALEKAR MARG, MAHIM, MUMBAI Phone- 011-29841697 Pincode : 400016 Email : lnsingh@polycab.com	
PVC WIRES	Electrical			ASIAN GALAXY PVT. LTD.	Mr. Vikas Garg, 203,Aditya Complex,Local Shopping Centre Sarita Vihar 110092 Phone- 011-43025843 Pincode : New Delhi Email : vikasgarg@v-marc.in	
PVC WIRES	Electrical			TAMRA DHATU UDYOG PVT. LTD.	MR. RAM KR SINGHEE, SAGAR ESTATE, UNIT NO #703, 2,N.C.DUTTA SARANI, KOLKATA Phone- 033 22315602/05 Pincode : 700001 Email : enquiry@tamradhatu.com	
PVC WIRES	Electrical			SUYOG ELECTRICALS LTD.	Mr.Bimal Y.Desai/Mr. Haresh Hansoti 1, Madhuvan Apartment,24 Arunoday Society,Alkapuri VADODARA Phone- 9227192737 Pincode : 390 007 Email : suyog@seplcables.com	
PVC WIRES	Electrical			SURAJ CABLES	C-412-413 , DSIDC INDUSTRIAL AREA, NARELA, DELHI Phone- 011-27781078 Pincode : 110040 Email : SURAJCABLES@GMAIL.COM	
PVC WIRES	Electrical			AVAIDS TECHNOVATORS PVT. LTD.	Shri Rajesh Piplani 4A/58, Shankar Road NEW DELHI Phone- 9910481854 Pincode : 110060 Email : rajendra@avaids.com,papandey@avaids.com	
PVC WIRES	Electrical			Pagoda Cables Pvt. Ltd.	Mr. Arun Kumar (MD), A-62, Sector - 58 Noida Phone- 01122392801 Pincode : 201301 Email : vishek.mittal@pagodacables.com	
PVC WIRES	Electrical			Hadron System Pvt. Ltd.	Mr. Tarun Gautam, 2400, Sector-9, Near IOCL Faridabad Phone- 01294037400 Pincode : 121006 Email : tarun.gautam@hadronpower.com	
PVC WIRES	Electrical			Zenium Cables Ltd.	H.O:102/103 Leena Heights,Opp.Thunga Hospital Mira Bhayander Road, Mira Road(E) Thane Phone- 02228114444 Pincode : 401107 Email : info@zeniumcables.com	
PVC WIRES	Electrical			GUPTA POWER INFRASTRUCTURE LIMITED,	Mr. NITISH KUMAR PARIDA ,502, 5th Floor, K M Trade Tower,Radisson Blu Complex, Sector-14, Kaushambi Ghaziabad Phone- 09861995978 Pincode : 201010 Email : info@guptapower.com	
Relay	electronics	relay		SALZER,		
Relay	electronics	relay		SIEMENS		
Relay	electronics	relay		SCHNIDER ELECTRIC.		
Relay	electronics	relay		SCHNEIDER TELEMECHANIQUE		
RH SENSOR/TEMP SENSOR	Electronics	sensor	RH PH	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
RH SENSOR/TEMP SENSOR	Electronics	sensor	RH PH	JOHNSON		
RH SENSOR/TEMP SENSOR	Electronics	sensor	RH PH	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
RH SENSOR/TEMP SENSOR	Electronics	sensor	RH PH	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
ROTAMETER	Electronics	INSTRUMENTS	Flow meter	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	Mr V. K. Pandit/Mr Ashish Shaha 17-20, Royal chambers, Paud Road Pune Phone- 9370469466 Pincode : 411038 Email : sales@eurekaflow.com	
ROTAMETER	Electronics	Instrument	indicator flow	TRANSDUCERS AND CONTROL		
ROTAMETER	Electronics	Instrument	indicator flow	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	Mr V. K. Pandit/Mr Ashish Shaha 17-20, Royal chambers, Paud Road Pune Phone- 9370469466 Pincode : 411038 Email : sales@eurekaflow.com	
ROTAMETER	Electronics	INSTRUMENTS	Flow meter	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
ROTAMETER	Electronics	Instrument	indicator flow	CHEMTROLS INDUSTRIES PVT. LTD.	Mr. K. NANDAKUMAR AMAR HILL, SAKI VIHAR ROAD, POWAI, MUMBAI Phone- 022-67151261 Pincode : 400072 Email : manikandan@chemtrols.com	
ROTAMETER	Electronics	INSTRUMENTS	Flow meter	TANSA EQUIPMENTS PVT. LTD.	Mr. Vardhan Tamhankar, Unit No35/36/41,Om Anand Industrial Est. Mohanjee Sundarjee Road,Raghunath Nagar, Thane Phone- 022-25832323 Pincode : 400604 Email : tansaindia@gmail.com	
ROTAMETER	Electronics	Instrument	indicator flow	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	
ROTAMETER	Electronics	Instrument	indicator flow	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	
ROTAMETER	Electronics	Instrument	indicator flow	FLOWTECH INSTRUMENTS SERVICRS		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
ROTAMETER	Electronics	Instrument	indicator flow	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone-9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
ROTAMETER	Electronics	INSTRUMENTS	Flow meter	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone-9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
ROTAMETER	Electronics	Instrument	indicator flow	IL		
ROTAMETER	Electronics	INSTRUMENTS	Flow meter	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone-9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	
Rubber lining	mechanical			Temsec Rubber Private Limited	153/1, Jessore Road, Baisakhi & Srabani Apartment Dum Dum, Near Amar Pally, South Dum Dum, Kolkata-700074, West Bengal, India Palash Paul (Director) 08048717861	
Rubber Lining	mechanical	Rubber lining		Rishi Industries	Address :40 L M Stone,GT Road Sonepat, Bahalgarh Road, Bahalgarh, Sonipat - 131001 , Haryana , India Contact Person :Mr. S D Bhutani (Proprietor) Phone :91-130-2381202 Mobile :+919992555844 State:Haryana Phone:91-1264-282801 Fax:91-1264-282899	
Rubber Lining				CORI ENGINEERS PVT LTD	No 2, Type II, VSI Estate, Rajiv Gandhi Salai (OMR), Thiruvanmiyur, Chennai - 600041 Ph: +91-44-42897500,+91-44-22542426, +91-44-22542421 Fax: +91-44-24405152 Email: oldone-cori@vsnl.com , sales@corirubber.com , Website: http://www.igp-group.co	
Rubber lining				POLY RUBBER PRODUCTS	Patanawala Estate, L.B.S. Marg, Ghatkopar(W), Mumbai, Maharashtra 400086 फोन: 022 2500 2246	
Rubber lining				Industrial Linings Baroda Pvt Ltd	Plot No. 254, Gidc Estate, Makarpura Industrial Estate, Vadodara - 390010 91-9992565412 Send SMS	
Rubber Lining				Arul Rubbers Private Limited	Corporate Office: ARUL RUBBERS PVT.LTD., B-5, SIDCO Industrial Estate HOSUR - 635 126, Krishnagiri Dt., Tamil Nadu, INDIA Marketing vp.marketing@arulrubbers.com mgr.marketing@arulrubbers.com +91 82200 40044 Technical Services tech.services@arulrubbers.co	
Rubber Lining	vessels	pressure		Jasmino Polymertech Pvt Ltd	Jasmino Polymertech Pvt Ltd M.Perumal (Manager) L ¿¿¿ 61, MIDC Taloja, MIDC Taloja, Raigad - 410208, Maharashtra, India Call Us: +91-9821948287	
Rubber Lining				Elastomer Lining Works Pvt Ltd	Office No, W-22/23, MIDC Chemical Zone, Chemical Zone, Ambernath South, Thane - 421501, Near Ordinance 0251 261 0723	
Rubber Lining				Emkay Rubber Works	Plot No. A-270 Road Number 33 Opposite ESIS Hospital, Thane, Maharashtra 400604 022 2582 1113	
Rubber Lining				Western Rubber Works Pvt. Ltd.	plot number R-73-74, MIDC, RABALE, THANE BELAPUR ROAD, Navi Mumbai, Maharashtra, 400701, India Supplier: Mr. Jiby Maliakkal Director	
SCREENED CONTROL CABLES	Electrical			Advance Cable Technologies (P) Ltd.	Mr. Siddharth Jain G-1, Sunrise Serenity, No.1,40 Ft.Road, M.R. Garden,Geddalahhalli, Aswathnagar, Bangalore Phone- 9845326881 Pincode : 560094 Email : dbhat@advancecable.in	
SCREENED CONTROL CABLES	Electrical			THERMO CABLES LTD.	Ms.UMA GHURKA/N.SRINIVASA RAO 28, NAGARJUNA HILLS, PUNJAGUTTA HYDERABAD Phone- 9397803596 Pincode : 500082 Email : isharma@thermocables.com	
SCREENED CONTROL CABLES	Electrical			KEI INDUSTRIES LTD.	Mr. ANIL GUPTA D-90, OKHLA INDUSTRIAL AREA, PHASE-I, NEW DELHI Phone- 011-26818840 Pincode : 110020 Email : lalit.saxena@kei-ind.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
SCREENED CONTROL CABLES	Electrical			CMI LTD.	Mr.Munishvar Gaur, 501-503,New Delhi House, 27,Barakhamba Road New Delhi, Phone-9599599244 Pincode : 110001 Email : mgaur@cmilimited.in	
SCREENED CONTROL CABLES	Electrical			CORDS CABLE INDUSTRIES LTD.	MR. NAVEEN SAWHNEY B-1/A-26, MOHAN CO-OPERATIVE INDUSTRIAL ESTATE, MATHURA ROAD, NEW DELHI Phone- 9818356799 Pincode : 110044 Email : sg@cordscable.com	
SCREENED CONTROL CABLES	Electrical			DELTON CABLES LTD.	MR. V.K. GUPTA 4801, BHARAT RAM ROAD, 24, DARYA GANJ, NEW DELHI Phone- 9560866060 Pincode : 110002 Email : shashikumar@deltoncables.com	
SCREENED CONTROL CABLES	Electrical			SERVEL INDIA PVT. LTD.	Mr.ALOK SAXENA, DGM - Business Developm S-15, Okhla Phase II New Delhi Phone-01126385900 Pincode : 110020 Email : asaxena@servelindia.com	
SCREENED CONTROL CABLES	Electrical			T C Communication Pvt. Ltd.	Mr. Ashok Bathwal 505, Vikas Deep, 18 Laxmi Nagar District Centre New Delhi Phone-9810002411 Pincode : 110092 Email : ashok@technocab.in	
SCREENED CONTROL CABLES	Electrical			POLYCAB INDIA LIMITED	HICO HOUSE, Ist FLOOR, 771, PANDIT SATWALEKAR MARG, MAHIM, MUMBAI Phone-011-29841697 Pincode : 400016 Email : lnsingh@polycab.com	
SCREENED CONTROL CABLES	Electrical			SPECIAL CABLES PVT. LTD.	MR.MUKUL KHANNA-VICE PRESIDENT B-II/12, Mohan Cooperative Industrial estate, Badarpur, Mathura Road NEW DELHI Phone- 9599186479 Pincode : 110044 Email : sales@specialcables.co.in	
SCREENED CONTROL CABLES	Electrical			ELKAY TELELINKS LTD.	Mr. Vinod Dubey K.C.HOUSE,5/66, PADAM SINGH ROAD, KAROL BAGH, NEW DELHI Phone-9899789830 Pincode : 110005 Email : projects@elkaygroup.net	
SCREENED CONTROL CABLES	Electrical			SUYOG ELECTRICALS LTD.	Mr.Bimal Y.Desai/Mr. Haresh Hansoti 1, Madhuvan Apartment,24 Arunoday Society,Alkapuri VADODARA Phone- 9227192737 Pincode : 390 007 Email : suyog@seplcables.com	
SCREENED CONTROL CABLES	Electrical			GUPTA POWER INFRASTRUCTURE LIMITED,	Mr. NITISH KUMAR PARIDA ,502, 5th Floor, K M Trade Tower,Radisson Blu Complex, Sector-14, Kaushambi Ghaziabad Phone- 09861995978 Pincode : 201010 Email : info@guptapower.com	
SCREENED CONTROL CABLES	Electrical			PARAMOUNT COMMUNICATIONS LTD.	Mr. Sanjay Aggarwal C-125, Naraina Industrial Area, Phase-I, NEW DELHI Phone- 9650005915 Pincode : 110028 Email : jatan.singh@paramountcables.com	
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	SCREW/SCROLL/CENTRIFUGAL/RECIPROCATING	BLUE STAR LIMITED	Jamshedji Tata Road, Mumbai - 400 020 Phone: (91) (22) 6665 4000 Fax: (91) (22) 6665 4151 www.bluestarindia.com	
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	NTRIFUGAL/RECIPROCATING	TRANE		
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	SCREW/SCROLL/CENTRIFUGAL/RECIPROCATING	VOLTAS	Corporate Headquarters Voltas Limited Voltas House 'A' Block Dr. Babasaheb Ambedkar Road Chinchpokli	
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	SCREW/SCROLL/CENTRIFUGAL/RECIPROCATING	KIRLOSKAR BROTHERS LTD.	KIRLOSKAR PRESS COMPOUND, UDYOG BHAWAN,TILAK ROAD, PUNE Phone-2447550,240672 Pincode : 411002 Email : kblin@kbl.co.in; gosain@del.kbl.co.in	
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	NTRIFUGAL/RECIPROCATING	DUNHAM BUSH		
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	NTRIFUGAL/RECIPROCATING	MCQUAY (DAIKIN)		
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	NTRIFUGAL/RECIPROCATING	CARRIER		
SCREW/SCROLL/CENTRIFUGAL /RECIPROCATING CHILLER	Mechanical	Chiller	NTRIFUGAL/RECIPROCATING	YORK		
SIGNAL CABLES	electrical	cable	Singnal	NICCO		
SIGNAL CABLES	electrical	cable	Singnal	THERMOCABLES		
SIGNAL CABLES	electrical	cable	Singnal	POLYCAB		
SIGNAL CABLES	electrical	cable	Singnal	PARAMOUNT CABLE		
SIGNAL CABLES	electrical	cable	Singnal	ELAKAY TELELINKS		
SIGNAL CABLES	electrical	cable	Singnal	UNIVERSAL		
SIGNAL CABLES	electrical	cable	Singnal	CORDS CABLE		
SIGNAL CABLES	electrical	cable	Singnal	KEI		
SIGNAL CABLES	electrical	cable	Singnal	RELIANCE ENGR.		
SIGNAL CABLES	electrical	cable	Singnal	DELTON		
Solenoid Valves	Mechanical	Valve	Solenoid	HERION		
Solenoid Valves	Mechanical	Valve	Solenoid	NUCON		
Solenoid Valves	Mechanical	Valve	Solenoid	ASCO		
Solenoid Valves	Mechanical	Valve	Solenoid	SMC		
Solenoid Valves	Mechanical	Valve	Solenoid	ROTEX		
Solenoid Valves	Mechanical	Valve	Solenoid	AVCON		
SPLIT AIR CONDITIONER	Mechanical	package	AC	HITACHI		
SPLIT AIR CONDITIONER	Mechanical	package	AC	CARRIER		
SPLIT AIR CONDITIONER	Mechanical	package	AC	LG		
SPLIT AIR CONDITIONER	Mechanical	package	AC	BLUE STAR LIMITED	Jamshedji Tata Road, Mumbai - 400 020 Phone: (91) (22) 6665 4000 Fax: (91) (22) 6665 4151 www.bluestarindia.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
SPLIT AIR CONDITIONER	Mechanical	package	AC	VOLTAS	Corporate Headquarters Voltas Limited Voltas House 'A' Block Dr. Babasaheb Ambedkar Road Chinchpokli	
SS PIPES (FOR SMALL QUAINTITY 500M)	Mechanical	pipe	SS	CHOKSI		
SS PIPES (FOR SMALL QUAINTITY 500M)	Mechanical	pipe	SS	RATNAMANI		
SS PIPES (FOR SMALL QUAINTITY 500M)	Mechanical	pipe	SS	REMI		
SS PIPES (FOR SMALL QUAINTITY 500M)	Mechanical	pipe	SS	APEX TUBES		
Stainless Steel Sheet	Mechanical	Metal	Sheet SS	JINDAL		
Stainless Steel Sheet	Mechanical	Metal	Sheet SS	SAIL,		
Stainless Steel Sheet	Mechanical	Metal	Sheet SS	MINOX METAL,		
Steel	Mechanical	Plates		IPA		
Steel	Mechanical	Plates		TISCO		
Steel	Mechanical	Plates		SARTORIUS		
Steel	Mechanical	Plates		SAIL		
Steel	Mechanical	Plates		JINDAL		
Steel	Mechanical	Plates		ESSAR		
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	V.K. VALVES PVT. LTD.,	C - 106, Focal Point Extn., Jalandhar, Phone- +91-181-5051947, Pincode : 144004, Email : info@vk-utam.com, ,kp.singh@vk-utam.com,	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	FLUIDLINE VALVES COMPANY PVT.LTD.	Mr. Balwant Mehra K.M. Trade Tower, Unit no. 905, 10thFlr Radisson Blu Hotel), Kaushambi Sec-14 Ghaziabad Phone- 0120-4242204 Pincode : 201010 Email : fluidlinedelhi@gmail.com	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	HAWA ENGINEERS LTD.	Mr. M. N. Pathan Plot No.129, Near Kashiram Textile Mill, Narol Road, Ahmedabad Phone- 079-25320781 Pincode : 382405 Email : pathan@hawaengltd.com	MOC:Cast Steel, Cast 150#, Size for Steel gate:upto 700 NB, for Steel NRV: upto 900 NB
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	INTERVALVE POONAWALLA LTD.	212/2, HADAPSAR, OFF SOLI POONAWALLA ROAD, PUNE Phone- '020-26602630 Pincode : 411028 Email : vkathuria@poonawallagroup.com	As per remarks column.
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	Hawa Valves (India) Pvt. Ltd.	Mr. Javed A Hawa R-16 & R-954, MIDC TTC Industrial Area, Sector 8, Rabale, Thane Belapur, Navi Mumbai Phone- 022-67760139 Pincode : 400701 Email : info@hawavalves.com	For Class #300, size upto 750 NB for CCS, CSS and Duplex-SS only.
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	Sap Industries Limited	10-A, Krishna Industrial Estate Nr. Sukhrampura Post Office Nagarvel Hanuman Road Ahmedabad Phone- 9879293029 Pincode : 380023 Email : pankaj@sapvalves.com	"Up to CL. 600 for sizes 65NB to 700NB with MOC as CCS/CSS/CAS only."
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	STEEL STRONG VALVES (I) PVT.LTD.,	STEEL STRONG VALVES (I) PVT.LTD., R-241, TTC. INDUSTRIAL AREA, RABALE, NAVI MUMBAI NAVI MUMBAI Phone- 022 27690074/5536 Pincode : 400701 Email : thomas@steelstrong.com	As per remarks column.
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	FOURESS ENGINEERING (INDIA) PVT. LTD.	MAHALAXMI CHAMBERS, 22, BHULBHAI DESAI ROAD, MUMBAI Phone- 24964400 Pincode : 400026 Email : info@fouressindia.com	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	ATAM VALVES PVT. LTD.	1051, OUTSIDE INDUSTRIAL AREA, JALANDHAR - 144004, PUNJAB JALANDHAR Phone- 0181 5019617 Pincode : 144004 Email : marketing@atamfebi.com	(1) Carbon Steel Gate Valves & non return valves: 15 NB to 50 NB (#800) & 65 NB to 300 NB (#150) (2) Carbon Steel Globe Valves: 15 NB to 50 NB (#800) & 65 NB to 200 NB (#150)
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	DLF Tower-B, Unit No: 1212, 1214 & 1215, 12th Floor, Jasola District Centre, Sarita Vihar, New Delhi - 110044 NEW DELHI Phone- 011-40503345/ 46/ 47 Pincode : 110044 Email : Brijesh.Manchanda@mail.weir	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	NITON VALVE INDUSTRIES PVT LTD	D-115, GHATKOPAR INDUSTRIAL ESTATE, L.B.S. MARG, GHATKOPAR(WEST), MUMBAI Phone- 25171315, 25171359 Pincode : 400086 Email : adib@nitonvalves.com	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	VALTECH INDUSTRIES	B-5 , NEW SONAL IND.ESTATE SAKI VIHAR ROAD MUMBAI Phone- Pincode : 400072 Email : farooq@valtechindustries.com	As per remarks column.
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	LEADER VALVES LTD.	Mr. Dharmvir Singh S-3, S-4, INDUSTRIAL TOWN, JALANDHAR Phone- 0181-2490666,777,888 Pincode : 144004 Email : dharmvir@leadervalves.com; info@leadervalves.com	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	Canle Valves Private Limited	No. 52, SIDCO Industrail Estate Pollachi Main Road Coimbatore Phone- 04222679972 Pincode : 641021 Email : marketing@canlevalve.com	"a) Steel Gate Valves: Size 65 NB to 500NB, #150 & MOC as CCS/CSS. b) Steel Check Valves: Size 65 NB to 350NB, #150 & MOC as CCS/CSS. c) Steel Globe Valves: Size 65 NB to 200NB, #150 & MOC as CCS/CSS."
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	NSSL PRIVATE LIMITED	F-8, MIDC INDUSTRIAL AREA, HINGNA ROAD, NAGPUR Phone- 07104-662500 Pincode : 440016 Email : delhi@nsslindia.com	
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	OSWAL INDUSTRIES LTD	Kartar Mansion, 3rd floor, Tribhuvan Road, Off Lamington road, Mumbai Phone- 022-61448000 Pincode : 400004 Email : ravi.doshi@oswalvalves.com	As per remarks column.

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	MICON VALVES (INDIA) PVT. LTD.	7, WADEE MANZIL, 2ND FLOOR, OPP. MEMON CO-OP. BANK, 75-77E, LADY JAMSHEDJI ROAD, MAHIM, MUMBAI Phone- 24460711/0712 Pincode : 400016 Email : miconvalve@vsnl.net	As per remarks column.
STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	Mechanical	Valve	Steel	A.V. VALVES LTD	Mr. Anil Sharma 16, INDUSTRIAL ESTATE NANHAI AGRA Phone- 05622281202 Pincode : 282 006 Email : info@avvalves.com,avvalves@sancharnet.in	
STRIP HEATER	Mechanical	Heater	Strip	DASPASS		
STRIP HEATER	Mechanical	Heater	Strip	ALCO		
STRIP HEATER	Mechanical	Heater	Strip	RACOLD		
STRIP HEATER	Mechanical	Heater	Strip	HEATCO		
STRIP HEATER	Mechanical	Heater	Strip	ESCORTS		
STRIP HEATER	Mechanical	Heater	Strip	HOTSET		
SUBMERSIBLE PUMP (DRAIN PUMP)	Mechanical	Pump		SU MOTORS		
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	
TEMP. ELEMENT	Electronics	INSTRUMENTS	Element Temp	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	
TEMPERATURE ELEMENT	Electronics	element	Temp	WAAREE INSTRUMENTS		
TEMPERATURE ELEMENT	Electronics	element	Temp	TECHNO INSTRUMENTS		
TEMPERATURE ELEMENT	Electronics	element	Temp	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	
TEMPERATURE ELEMENT	Electronics	element	Temp	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	
TEMPERATURE ELEMENT	Electronics	element	Temp	Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com	
TEMPERATURE ELEMENT	Electronics	element	Temp	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
TEMPERATURE ELEMENT	Electronics	element	Temp	Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com	
TEMPERATURE ELEMENT	Electronics	element	Temp	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in	
TEMPERATURE ELEMENT	Electronics	element	Temp	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com	
TEMPERATURE ELEMENT	Electronics	element	Temp	TM TECNOMATIC SPA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
TEMPERATURE ELEMENT	Electronics	element	Temp	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
TEMPERATURE ELEMENT	Electronics	element	Temp	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : gtilworks@pyro-electric.in	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	BUDENBERG GUAGE CO.LTD.		
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	ASHCROFT INDIA PVT LTD.		
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	WIKA		
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	
TEMPERATURE GAUGE	Electronics	INSTRUMENTS	Gauge Temperature	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	WAREE INSTRUMENTS		
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : gtilworks@pyro-electric.in	
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	FORBES MARSHAL PVT. LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
TEMPERATURE GAUGE	Electronics	Instrument	Gauge Temp	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
TEMPERATURE SWITCH	Electronics	INSTRUMENTS	Switch Temp	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	VASU		
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	DK INSTRUMENTS		
TEMPERATURE SWITCH	Electronics	INSTRUMENTS	Switch Temp	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	SEIMENS		
TEMPERATURE SWITCH	Electronics	INSTRUMENTS	Switch Temp	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com	
TEMPERATURE SWITCH	Electronics	Instrument	Switch Temp	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mktg@indfos.com	
TEMPERATURE SWITCH	Electronics	INSTRUMENTS	Switch Temp	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
TEMPERATURE SWITCH	Electronics	INSTRUMENTS	Switch Temp	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone-9810005826 Pincode : 110 020 Email : sales@vautomat.com	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	147, KARAPAKKAM VILLAGE, CHENNAI Phone-23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	YOKOGAWA	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	MOORE		
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone-9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
TEMPERATURE TRANSMITTER	Electronics	Transmitter	Temp	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	
TERMINAL BOX	Mechanical	TERMINAL BOX		SUPPLIERS/SUB-VENDORS		
THERMOSTATS	Electrical	Thermostat	Normal	RANCO		
THERMOSTATS	Electrical	Thermostat	Normal	PENN		
THERMOSTATS	Electrical	Thermostat	Normal	JHONSON CONTROL		
THERMOSTATS	Electrical	Thermostat	Normal	DANFOSS		
THERMOSTATS	Electrical	Thermostat	Normal	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone-9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
THERMOSTATS	Electrical	Thermostat	Normal	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mktg@indfos.com	
THERMOSTATS	Electrical	Thermostat	Normal	RANUTROL		
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	Moore Industries International Inc		
TRANSMITTERS	Electronics	Transmitter		Moore Industries International Inc.	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com	
TRANSMITTERS	Electronics	Instrument	Transmitter	NIVO CONTROLS PVT. LTD.		
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	NIVO CONTROLS PVT. LTD.		
TRANSMITTERS	Electronics	Instrument	Transmitter	Moore Industries International Inc		
TRANSMITTERS	Electronics	Transmitter		TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	
TRANSMITTERS	Electronics	Instrument	Transmitter	LAXONS AUTOMATION		
TRANSMITTERS	Electronics	Instrument	Transmitter	YIL		
TRANSMITTERS	Electronics	Instrument	Transmitter	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	
TRANSMITTERS	Electronics	Transmitter		SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	LD-301 & T-301 TRANSMITTER FROM M/S SMART EQUIPMENTS BRAZIL.
TRANSMITTERS	Electronics	Transmitter		Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,L		
TRANSMITTERS	Electronics	Transmitter		ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	PRESSURE TRANSMITTER, DP TRANSMITTER and TEMP TRANSMITTER
TRANSMITTERS	Electronics	Instrument	Transmitter	FUJI		
TRANSMITTERS	Electronics	Instrument	Transmitter	FISHER-ROSEMOUNT		
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
TRANSMITTERS	Electronics	Transmitter		Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,	"Except Displacement Type Level Transmitters"
TRANSMITTERS	Electronics	Instrument	Transmitter	Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,	
TRANSMITTERS	Electronics	Instrument	Transmitter	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	
TRANSMITTERS	Electronics	Transmitter		EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	V AUTOMATION & INST		
TRANSMITTERS	Electronics	Instrument	Transmitter	ABB India Limited	Mr.Tommy Andreson/Mr.Naveen Maikhuri PLOT NO.79, STREET NO.17 VADODARA Phone- 9958188524 Pincode : 390013 Email : rizwan.siddiqui@in.abb.com	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.		
TRANSMITTERS	Electronics	Instrument	Transmitter	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	147, KARAPAKKAM VILLAGE, CHENNAI Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	
TRANSMITTERS	Electronics	Transmitter		NIVO CONTROLS PVT. LTD.	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com	For Capacitance type only
TRANSMITTERS	Electronics	Transmitter		V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	a)DISPLACEMENT TYPE TRANSMITTERS. b)PRESSURE AND DP TRANSMITTERS
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	Honeywell Automation India Limited		
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd		
TRANSMITTERS	Electronics	Transmitter		YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	SBEM PVT. LTD.		
TRANSMITTERS	Electronics	Instrument	Transmitter	TAYLOR		
TRANSMITTERS	Electronics	Instrument	Transmitter	BIRLA KENT TAYLOR		
TRANSMITTERS	Electronics	Transmitter		SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	FOR CAPACITANCE TYPE.
TRANSMITTERS	Electronics	Instrument	Transmitter	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	SIEMENS		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
TRANSMITTERS	Electronics	Instrument	Transmitter	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
TRANSMITTERS	Electronics	Instrument	Transmitter	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	SIEMENS LIMITED		
TRANSMITTERS	Electronics	Instrument	Transmitter	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	
TRANSMITTERS	Electronics	Instrument	Transmitter	BRISTOL BABCOCK		
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	YOKOGAWA INDIA LIMITED,		
TRANSMITTERS	Electronics	Transmitter		Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	Only for capacitance Type Level Transmitter
TRANSMITTERS	Electronics	Instrument	Transmitter	Honeywell Automation India Limited		
TRANSMITTERS	Electronics	Instrument	Transmitter	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	Pune Techtrol Pvt. Ltd		
TRANSMITTERS	Electronics	Transmitter		SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	
TRANSMITTERS	Electronics	Instrument	Transmitter	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
TRANSMITTERS	Electronics	Instrument	Transmitter	YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	
TRANSMITTERS	Electronics	Instrument	Transmitter	PANAM ENGINEERS		
TRANSMITTERS	Electronics	Transmitter		PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,	For Pressure and Diff. Pressure transmitter
TRANSMITTERS	Electronics	INSTRUMENTS	TRANSMITTERS	SMART INSTRUMENTS LTD		
ULTRASONIC FLOW METERS	Electronics	Instrument	Meter Flow Ultrasonic	Rockwin Flowmeter India Pvt. Ltd.	B-24, Site-IV, Sahibabad Industrial Area Ghaziabad, Phone- 9810129687 Pincode : 201010, Email : amiya@rockwin.com	
ULTRASONIC FLOW METERS	Electronics	Instrument	Meter Flow Ultrasonic	Adept Fluidyne Pvt. Ltd.	Vinayak Gadre Plot No 4,S.No.17/1-B Kothrud Industrial Estate Pune Phone- 020 25464551 Pincode : 411038 Email : info@adeptfluidyne.com	
ULTRASONIC FLOW METERS	Electronics	Instrument	Meter Flow Ultrasonic	FLEXIM Flexible Industriemesstechnik GmbH	Boxberger Str., 4, Berlin Berlin Phone- 0049 30 93 66 76 60 Pincode : 12681 Email : info@flexim.de	
ULTRASONIC FLOW METERS	Electronics	Instrument	Meter Flow Ultrasonic	NIVUS GMBH	Mr. Marcus Fischer Im Taele 2, D - 75031 Eppingen Phone- 00491712233770 Pincode : Email : carolin.schuster@nivus.com	
ULTRASONIC FLOW METERS	Electronics	Instrument	Meter Flow Ultrasonic	Electronet Equipments Pvt Ltd.	Plot No. 84, 85 & 86, Tiny Industrial Estate Kondhwa Budruk, Pune Phone- 020-2026932039 Pincode : 411048 Email : ho@eeplindia.com	
ULTRASONIC FLOW METERS	Electronics	Instrument	Meter Flow Ultrasonic	FLASH FORGE PVT LTD	Mr. Gautam Makker, 503, 'A'-wing, Delphi, Orchard Avenue Road, Powai Mumbai Phone- 022-42784300 Pincode : 400076 Email : hemendrapatil@f-f.co.in	
V- BELT	Mechanical	belt	V	FENNER		
V- BELT	Mechanical	belt	V	DUNLOP		
VAPOUR ABSORBTION MACHINE	Mechanical	VAM		KIRLOSKAR BROTHERS LTD.	KIRLOSKAR PRESS COMPOUND, UDYOG BHAWAN,TILAK ROAD, PUNE Phone- 2447550,240672 Pincode : 411002 Email : kblin@kbl.co.in; gosain@del.kbl.co.in	
VAPOUR ABSORBTION MACHINE	Mechanical	VAM		THERMAX LTD.	Anil Oza (Head Sales and Market), Environmental House, 3rd Floor, B Wing, Bhosari MIDC, Bhosari, PUNE Phone- 9823940318, Pincode : 411026 Email : msogani@thermaxindia.com	
VAPOUR ABSORBTION MACHINE	Mechanical	VAM		VOLTAS	Corporate Headquarters Voltas Limited Voltas House 'A' Block Dr. Babasaheb Ambedkar Road Chinchpokli	
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		YASKAWA		
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		SCHNIEDER		
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		FUJI ELECTRIC		
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		SIEMENS		
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		MITSUBISHI ELECTRIC		
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	
VVVF/VFD / INVERTOR (V3F)	Electronics	Inverter		Toshiba		
Y / POT STRAINER	Mechanical	Strainer	Pot	OTOKLIN GLOBAL BUSINESS LTD		
Y / POT STRAINER	Mechanical	Strainer	Pot	GRAND PRIX ENGINEERING PVT. LTD.	Mr. B.S. Dhillon, Plot No. 82, Sector 25, Faridabad Phone- 0129-4097716 Pincode : 121004 Email : bsdhillon@grandprixfilters.com	
Y / POT STRAINER	Mechanical	Strainer	Pot	GREAVES COTTON		

Package Name	Generic classificati	Sub-Class	Type	Supplier Name	Supplier Communication Address	Tech Limit
Y / POT STRAINER	Mechanical	Strainer	Pot	GUJARAT OTOLIFT		
Y / POT STRAINER	Mechanical	Strainer	Pot	BHATIA ENGINEERING CO.	6, DSIDC, JHILMIL INDUSTRIAL AREA, G.T.ROAD, SHAHDARA. DELHI Phone- 22583488, 55258066 Pincode : 110095 Email : sales@strainwell.com	
Y / POT STRAINER	Mechanical	Strainer	Pot	SUNGOV ENGINEERING		
Y / POT STRAINER	Mechanical	Strainer	Pot	DS ENGG		
Y / POT STRAINER	Mechanical	Strainer	Pot	MULTITEX FILTRATION ENGINEERS LIMITED	FILTRATION DIVISION, 217, HANS BHAWAN, BAHADURSHAH ZAFAR MARG, NEW DELHI Phone- 23378015/0923/0479 Pincode : 110002 Email : rajesh@multitexfilters.com	
Y / POT STRAINER	Mechanical	Strainer	Pot	SANT VALVES		
Y / POT STRAINER	Mechanical	Strainer	Pot	SAROJINI ENTERPRISE		
Y / POT STRAINER	Mechanical	Strainer	Pot	JAYPEE		
Y / POT STRAINER	Mechanical	Strainer	Pot	FILTERATION ENGINEERS (I) PVT. LTD.	Plot No. W-62 (B) T.T.C Industrial Area MIDC , Rabale Navi Mumbai Phone- 02227608501 Pincode : 400701 Email : sales@feipl.com	

AIR CONDITIONING SYSTEM

LIST OF MAKES OF SUB-VENDOR ITEMS

SI. NO.	ITEM / EQUIPMENT	SUB SUPPLIER
1	SCREW CHILLER	YORK / TRANE / CARRIER / KIRLOSKAR / DUNHAM BUSH / MCQUAY (DAIKIN) / BLUE STAR / VOLTAS
2	VAPOUR ABSORBTION MACHINE	VOLTAS / THERMAX
3	PRECISION PACKAGE UNITS	STULZ / UNIFLAIR / EMERSON / BLUEBOX / CLIMADENTA
4	PACKAGE UNIT	VOLTAS / BLUE STAR / CARRIER
5	SPLIT AIR CONDITIONER	VOLTAS / BLUE STAR / CARRIER / HITACHI / LG
6	AIR HANDLING UNITS	VOLTAS / BLUE STAR / ZECO / CARRYAIRE(FLAKT) / EDGETECH / ETHOS / SYSTEM AIR / WAVES AIRCON
7	AHU FAN (CENTRIFUGAL FAN)	CB.DOCTOR / FLAKT / KRUGER / NICOTRA / COMEFRI / MARATHON / PATEL AIR
8	CHILLED & CONDENSER 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
9	COOLING TOWER	PAHARPUR / MIHIR / PCT / FLOWTECH / BELL
10	INDUCTION MOTORS (LT)	SIEMENS / ABB / CGL / MARATHON / KEC / BHARAT BIJLEE / NGEF /JYOTI / LHP
11	AIR FILTER	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER / SPECTRUM / AIR TECH / PUROMATIC
12	AXIAL FANS / F.A. FANS	FLAKT / KHAITAN / PATEL / NICOTRA / SARLA / KRUGER / MARATHON / C DOCTOR
13	INSULTATION MATERIAL	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA /AEROCELL
14	BALANCING VALVE	ADVANCE
15	BUTTERFLY VALVE	AUDCO / FOURESS / INTER VALVE / BDK / WEIR BDK / TYCO / CRANE PROCESS / KEYSTONE
16	NON RETURN VALVE	LEADER / H.SARKAR / FLUID LINE / HI -TECH / CRESENT / A V VALVES / BANKIM & COMPANY / SHIVADURGA
17	GATE/GLOBE VALVES	CRESENT / BDK / AUDCO / FOURESS / KIRLOSKAR / SANT / BOMBAY METAL & ALLOYS / BANKIM / LEADER / H SARKAR / AV VALVES / VENUS PUMPS AND ENGG/SAMSON CONTROLS PVT. LTD/INSTRUMENTATION LTD./ Koso India Private Limited,

18	3 WAY MIXING VALVE WITH ACTUATING MOTOR	SIEMENS BUILDING TECHNOLOGY /JOHNSON / BELIMO / HONEYWELL / RAPID CONTROL / ALC
19	MOTORIZED BUTTERFLY VALVE	ANERGY / ADVANCE / BELIMO / JOHNSON / HONEYWELL / SIEMENS
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	PIPING - ERW	SURYA ROSHNI / TISCO / DADU PIPES / INDUS TUBE / WELSPUN / TATA / BST / JINDAL / SAIL
22	PIPING - CS SEAMLESS (ASTM A 106)	ISMT / MAHARASHTRA SEAMLESS
23	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
24	FIRE DAMPER	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
25	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW/ TSC /AIR MASTER/ CARYAIRE/RAVI STAR (SYSTEM AIR)
26	STRIP HEATER	ESCORTS / RACOLD / DASPASS/ ALCO/ HEATCO / HOTSET
27	PAN HUMIDIFIER	RAPID COOL/ HOTSET /ALCO
28	RELIEF / PURGE VALVE	BRASSOMATIC
29	THERMOSTATS	HONEYWELL / RANCO / PENN / DANFOSS / INDFOSS / JHONSON CONTROL /RANUTROL
30	HUMID STAT	JHONSON CONTROL / HONEYWELL / PENN
31	ANTI FREEZE THERMOSTAT	RANCO / HONEYWELL / PENN / DANFOSS / INDFOSS
32	FLOW SWITCH	SWITZER / LEVCON / DK INSTRUMENT / SBEM / V. AUTOMATE/ SIEMENS
33	FLOW METER	EUREKA / INSTRUMENTATION ENGINEERS PVT LTD / PLACKA /TRAC / FLOW STAR/ SCIENTIFIC DEVICE
34	RH SENSOR/TEMP SENSOR	HONEY WELL /JOHNSON /SIEMENS / GENERAL INSTRUMENTS
35	PLC BASED PANEL	SIEMENS / SCHENIEDER / ROCKWELL / GE INTELLIGENT / HONEYWELL AUTOMATION / ABB/ MITSUBISHI ELECTRIC
36	OWS / PC	HP / COMPAQ / DELL / HCL / IBM / LENOVO
37	PRINTER	HP / CANON / EPSON / XEROX / IBM / LEXMARK
38	UPS	HITACHI-HIREL / APC / DELTA / EMERSON / DB POWER / APLAB
39	FIBRE OPTIC CABLE	BIRLA ERICSON / FINOLEX / AKSH FIBRE
40	ANNUNCIATOR FOR PANEL	ICC / PECON/ PROCON
41	LT ADAPTER BOX FOR AL TO CU CABLE CONVERTOR	CONTROL DEVICE / SYSTEM POWER CONTROL / JACKSON / UNILEC / ELECTRIC ALLIED PRODUCT
42	METERING PUMP	SHAPO TOOLS / VK PUMPS
43	WATER SOFTENING PLANT	THERMAX / ION EXCHANGE / DOSI ION
44	PRESSURE TRANSMITTER	ABB / ENDRESS + HAUSER (INDIA) / MOORE / SIEMENS / SMART INSTRUMENT BRAZIL / SBEM /

		TOSHNIWAL / V. AUTOMAT / EMERSON / YOKOGAWA / HONEYWELL / FUJI
45	TEMPERATURE TRANSMITTER	ABB / ENDRESS + HAUSER (INDIA) / MOORE / SIEMENS / SMART INSTRUMENT BRAZIL / SBEM / TOSHNIWAL / V. AUTOMAT / EMERSON / YOKOGAWA / HONEYWELL
46	ROTAMETER	CHEMTROLS SAMIL / EUREKA IND / IL / TRANSDUCERS AND CONTROL
47	BATTERY CHARGER	AMARARAJA/ CHHABI ELECTRICAL / DUBAS ENGG. / HBL POWER SYSTEM / STATCON / CALDYNE
48	BATTERY (NI -Cd)	HBL POWER / AMCO SAFT / SAFT

NOTE	
	NOTES: 1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED. 2. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER. 3. PLEASE ALSO REFER RESPECTIVE SUB-SECTION C-3, C-4 & C-5 FOR ELECTRICAL, C&I AND HANDLING RELATED EQUIPMENT LIST OF MAKE.

ANNEXURE-II

MANDATORY SPARE LIST

NAME OF PROJECT:		5X800 MW TSGENCO YADADRI TPS	
NAME OF PACKAGE:		AIR CONDITIONING SYSTEM	
TECHNICAL SPECIFICATION:		PE-TS-417-553-A002	
S. No.	DESCRIPTION EQUIPMENT / PACKAGE	UNIT	Qty
1	**Air Conditioning System**		
1.1	Screw Chiller (for each type and rating)		
1.1.1	Bearing for the compressor	Set	2 Sets
1.1.2	Gaskets as applicable for Condenser & Chiller Heads	Set	2 Sets for each category
1.2	Centrifugal Pump (for each type and rating)	%	10% of one Condenser
1.2.1	Bearings for each pump and motor	Set	4 Sets for each category
1.2.2	Mechanical seal,wearing rings and lantern rings	Set	2 Sets for each category
1.3	Cooling Tower (for each type and rating)		
1.3.1	Spray nozzles	Set	20% of one Tower
1.3.2	Set of fills	Set	20% of one Tower
1.3.3	Bearings for each fan and motor	Set	4 sets
1.4	Refrigerant & Oil		
1.4.1	Refrigerant gas in a non-returnable cylinder	Nos.	30% of installed charge
1.4.2	Empty cylinders of 68Kg capacity to hold the charge of the highest capacity system	-	As required to suit the above
1.4.3	Filter oil in sealed tins for the full set for 6 operations of cleaning	-	As required
1.5	Air Handling Units (for each rating)		
1.5.1	Bearings for each AHU blower & motor	Set	2 Sets for each category
1.5.2	V-Belts	Set	4 Sets for each category
1.5.3	Filters of each type	Set	4 Sets for each category
1.6	Centrifugal fans (For each type and rating)		
1.6.1	Bearings for fan & motor	Set	4 Sets for each category
1.6.2	V-belts	Set	2 Sets for each category
1.6.3	Vibration Isolators	Set	2 Sets
1.7	**Precision Air Conditioners**		
1.7.1	Vibration Isolators	Set	2 Sets for each category
1.7.2	Filters	Set	2 sets for each PAC unit
1.7.3	Bearings	Set	2 sets for each rating of PAC unit (both for condenser & Indoor Unit)
1.7.4	Condenser fan Impeller	Set	2 sets for each PAC unit
1.7.5	Expansion valve	Set	2 sets for each rating of PAC unit
1.7.6	Any other spare parts recommended by the Manufacturer	Set	2 sets for each rating of PAC unit

S. No.	DESCRIPTION	UNIT	Qty
	EQUIPMENT / PACKAGE		
1.8	Split Air Conditioners		
1.8.1	Fan-motor bearing for outdoor unit	Set	2 sets for each rating of SAC unit
1.8.2	Vibration Isolators	Set	2 sets each for outdoor unit & Indoor unit for each SAC unit
1.8.3	Filter	Set	2 sets for each SAC unit
1.8.4	Expansion valve	Set	2 sets for each rating of SAC unit
1.8.5	Any other spare parts recommended by the Manufacturer	-	As recommended by the Manufacturer
1.8	**Cassette AC unit**		
1.9.1	Fan-motor bearing for outdoor unit	Set	2 sets for each rating
1.9.2	Vibration Isolators	Set	2 sets each for outdoor unit & Indoor unit for each unit
1.9.3	Filter	Set	2 sets for each unit
1.9.4	Expansion valve	Set	2 sets for each rating
1.9.5	Any other spare parts recommended by the Manufacturer	-	As recommended by the Manufacturer
1.10	**Package Air Conditioners**		
1.10.1	Vibration Isolators	Set	2 Sets for each category
1.10.2	Filters	Set	2 sets for each PAC unit
1.10.3	Bearings	Set	2 sets for each rating of PAC unit (both for condenser & Indoor Unit)
1.10.4	Condenser fan Impeller	Set	2 sets for each PAC unit
1.10.5	Expansion valve	Set	2 sets for each rating of PAC unit
1.10.6	Any other spare parts recommended by the Manufacturer	Set	2 sets for each rating of PAC unit
2	**Electrical Spares**		
2.1	**415 Volt Motor (above 30KW Rating upto200KW)**		
2.1.1	End Shield Cover Driving & Non-Driving End	Set	2 Set for each type and rating of Motor
2.1.2	Driving End & Non-Driving End Bearing	Set	2 Set for each type and rating of Motor
2.1.3	Cooling Fan	Nos.	2 Nos. for each type and rating of Motor
2.1.4	Motor Space Heater	Nos.	2 Nos. for each type and rating of Motor
2.1.5	Motor Terminal Block	Nos.	2 Nos. for each type and rating of Motor
2.1.6	Complete Set of Coupling	Set	2 Set for each Application

S. No.	DESCRIPTION	UNIT	Qty
	EQUIPMENT / PACKAGE		
2.2	**415 Volt Motor (Upto 30KW Rating)**		
2.2.1	Driving End & Non-Driving End Bearing	Set	6 Set for each type and rating of Motor
2.2.2	Cooling Fan	Nos.	4 No. for each type and rating of Motor
2.2.3	Motor Terminal Block	Nos.	10 No. for each type and rating of Motor
2.2.4	Complete Set of Coupling	Set	2 Set for each Application
2.3	**Electrical Spares for Motors**		
2.3.1	Terminal plates	Nos	20 Nos. each for small motors up to 30KW and 8 Nos. each for motors above 30 KW
2.3.2	Heaters	Sets	2 Sets for each motor of rating above 30 KW
2.3.3	Greasing arrangements	Sets	8 sets for each type of motors
2.3.4	Motors below 0.75 KW	Nos	20% of the installed quantity or minimum 2 no. whichever is higher
2.3.5	Bearings (DE & NDE)	Sets	8 sets of each type and rating
2.4	**Electrical Spares**		
2.4.1	Control Supply Transformer	Nos	4 Nos. of each type and rating
2.4.2	Contactor	Nos	4 Nos. of each type and rating
2.4.3	Coils for contactor & aux. Contactor	Nos	10 Nos. for each contactor
2.4.4	Main&Aux.ContactssetsforcontactorandAux.Contactor	Sets	10 Sets. for each contactor
2.4.5	Air Break Switch	Nos	2 Nos. for each rating
2.4.6	Control ,Isolating and selector switches	%	10% of each type and rating
2.4.7	MCB/MCCB	%	20% of installed quantity
2.4.8	Circuit Breaker	Nos	2 Nos. for each rating
2.4.9	Indicating Lamps	%	20% of installed quantity
2.4.10	Indicatinglampscoverofdifferentcolourandholders	%	10% of installed quantity
2.4.11	Push Buttons of various colours	Nos	20 nos. of each type and colour
2.4.12	Terminal Blocks	%	10% of installed quantity
2.5	**HT Motor (other than BFP Motor)**		
2.5.1	Driving End Bearing	Nos	2Nos. (or 2Set as applicable) for each type and rating of Motor
2.5.2	Non-Driving End Bearing	Nos	2Nos. (or 2Set as applicable) for each type and rating of Motor
2.5.3	Cooling Fan Internal & External	Sets	2Sets for each type and rating ofMotor
2.5.4	Bearing Temperature Gauge Driving & Non-Driving End	Sets	2Sets for each type and rating ofMotor
2.5.5	Phase-Segregated Terminal Box	Sets	2Sets for each type and rating ofMotor

S. No.	DESCRIPTION	UNIT	Qty
	EQUIPMENT / PACKAGE		
2.5.6	Neutral End Terminal Bushing with Fasteners	Nos	2Nos. for each type and rating ofMotor
2.5.7	RTD for Bearing Temperature	Nos	2Nos. for each type and rating ofMotor
2.5.8	Motor Space Heater	Nos	2Nos. for each type and rating ofMotor
2.5.9	Complete Set of Coupling	Sets	2Sets for each Application
3	**C&I Spares**		
3.1	Actuator		
3.1.1	Complete set of Actuator	Nos.	2Nos. for each type and rating
3.1.2	Limit Switch	Nos.	6 Nos each type and rating
3.1.3	Torque Switch	Nos.	6 Nos each type and rating
3.1.4	Auxiliary Contact	Nos.	2 nos each type and rating
3.1.5	Motor	Nos.	2 nos each type and rating
3.1.6	Complete Seal kit	Set	2Sets for each type and rating
3.1.7	Complete O-Ring Set	Set	2Sets
3.1.8	Electronic Card	Nos.	Two(2) for each type/make
3.1.9	Feedback Assembly (4-20mA) for Inching type	Nos.	Two(2) for each type/make
3.3	Field Instruments		
3.3.1	Transmitters/ Gauges/Switches etc. along with relevant accessories	Nos.	20% of total or at least four (whichever is higher) for eachtype along with accessories.
3.3.2	Temperature Element (RTD/Thermo-couple) with thermowell	Nos.	20% of each type , range and immersion length . Minimum 10 nos.
3.4	**Control Valves and Dampers**		
3.4.1	Pneumatic Control Valves & Block Valves		
3.4.1.1	Plot Relay	Set	2 sets for each valve
3.4.1.2	Actuator Diaphragm	Set	2 nos.for each valve
3.4.1.3	Feedback Linkage	Set	2 nos.for each valve
3.4.1.4	Smart Positioners	Nos.	20% of total quantity of each model/type
3.4.1.5	I/P Converters (If any)	Nos.	20% of total quantity or minimum 30 nos.
3.4.1.6	Complete Consumables for Valve Viz. O-ring, Gland Packing, Packing Ring, Bonnet Seal etc	Set	4 Sets each size, rating, type
3.4.1.7	Valve Disc	Set	4 Sets each size, rating, type
3.4.1.8	Valve Spindle	Set	4 Sets each size, rating, type
3.4.1.9	Valve Seat	Set	4 Sets each size, rating, type

S. No.	DESCRIPTION EQUIPMENT / PACKAGE	UNIT	Qty
3.4.1.10	Bush	Set	4 Sets each size, rating, type
3.4.1.11	Guide	Set	4 Sets each size, rating, type
3.4.1.12	Guide Bush	Set	4 Sets each size, rating, type
3.4.1.13	Coupling Nut	Set	4 Sets each size, rating, type
3.4.1.14	Actuator Piston with Rod & Seal	Set	4 Sets each size, rating, type
3.4.1.15	Control valve stem packing and spare operator moulded rubber diaphragms	Set	2 sets for each size, rating, type
3.4.1.16	Valve trim (including cage, plug, stem, seat rings, guide bushings etc.) for each of the control valves as offered.	Set	2 sets for each size, rating, type
3.4.1.17	Solenoid valves, position transmitters, limit switches, I/P convertors, positioners etc of each type	Nos.	20% of total quantity spare with minimum 2 no. for each size, rating, type
3.4.2	**Dampers**		
3.4.2.1	Actuator Diaphragm	Set	2 set for each damper
3.4.2.2	O-Ring set	Nos.	2 nos. of each size for positioner
3.4.2.3	Feedback Linkage	Nos.	2 no.for each type
3.4.2.4	Packing & gasket	Nos.	2no.for each type
3.4.3	**Solenoid Valves**		
3.4.3.1	Solenoid Valve Coil	Nos.	4 nos. of each rating & insulation
3.4.3.2	Plunger	Nos.	2 nos. of each type
3.4.3.3	Seat	Nos.	4 nos. of each type & size
3.4.3.4	Gaskets	Set	4 sets of each type & size
3.4.3.5	O-Ring set	Set	10 sets of each type & size
3.5	**Flow Elements**		
3.5.1	Root valves	Nos.	4 nos. for each flow element
3.5.2	Gland packing for root valves	Nos.	4 nos. for each flow element
3.5.3	Gaskets	Nos.	6 nos. for each flow element
3.6	**Process Connection Piping (Impulse piping/tubing, sampling piping / tubing & air supply piping as applicable)**		
3.6.1	Valves of all types	Nos.	20% of each type, class, size & model
3.6.2	Valve Manifolds (2 way/3 way/5 way)	Nos.	20% of each type, class, size & model
3.6.3	Fittings	Nos.	20% of each type, class, size & model
3.6.4	Filter Regulators	Nos.	40% of each model
3.7	Cables (Control & Instrumentation) incldluing FO cable as per Electrical scope matrix	Mtr	20% of each type, pair and size of actual installed quantity
3.8	**Control Panel/ Desk**		
3.8.1	Back-up panel mounted devices (Selector switches/ Push buttons/ Indicators etc.)	Nos.	10% of installed capacity
3.8.2	Lamps/ LEDs	Nos.	200% of the total quantity
3.8.3	Blank Tiles	Nos.	20% of installed capacity
3.8.4	MCBs	Nos.	20% of each type & rating
3.8.5	Fuses/ Fuse holder	Nos.	200% of each type & rating
3.8.6	Push Button		
3.8.6.1	Complete assembly	Nos.	10Nos for each colour
3.8.6.2	Contact Element (1NO + 1NC) Block	Nos.	40Nos.
3.8.7	Selector Switch	Nos.	20Nos. for each type and rating
3.8.8	Meter (Analog or Digital)		
3.8.8.1	Ammeter	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more
3.8.8.2	Voltmeter	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more

S. No.	DESCRIPTION EQUIPMENT / PACKAGE	UNIT	Qty
3.8.8.3	Frequency	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more
3.8.8.4	MW	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more
3.8.8.5	MVAR	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more
3.8.8.6	Power Factor	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more
3.8.8.7	Synchroscope	Nos.	20% for each type and rating or minimum Two (2) no. whichever is more
3.8.9	Indicating Lamps complete assembly	Nos.	20Nos. for each Colour and type
3.8.10	Mimic Lamps	Nos.	20Nos. for each Colour and type
3.8.11	MCB	Nos.	4Nos. for each type and rating
3.8.12	Door Limit Switch	Nos.	4Nos.
3.8.13	Annunciation system		
3.8.13.1	Lamp Box with Facia & Lamps (LED type)	Nos	50Nos.
3.8.13.2	Hooter	Nos	2Nos.
3.8.13.3	Each type of PCB (for non-PLC driven system)	Nos	2Nos.
3.9	**Junction Box**		
3.9.1	Junction box	Nos.	10% of total quantity for each size but minimum 2 nos.
3.9.2	Terminals in Terminal blocks	Nos.	10 nos. of each type
3.10	**PLC/ Proprietary Control System**		
3.10.1	Network cards, Communication Interface cards	Nos.	10% for each type or but minimum 2 no.
3.10.2	I/O Cards (Each type)	Nos.	10% for each type but minimum 2 nos.
3.10.3	Controller Cards	Nos.	4 nos.
3.10.4	SER Cards	Nos.	10% for each type or but minimum 2 no.
3.10.5	All other Electronic Modules	Nos.	10% for each type or but minimum 2 no.
3.10.6	Relays	Nos.	20% of total quantity
3.10.7	Power Supply Modules & Power Packs for control system	Nos.	10% for each type and range but minimum 2 nos. .
3.10.8	Network Items (Network switch/ LIU unit/ Transceiver/ FO patch cord etc.)	Nos.	20% of total nos. used for each type and model in the system or minimum 4(four) no. whichever is more.
3.10.9	MCB (Miniature case circuit breaker)	Nos.	20% or minimum 20 nos. whichever is higher for each type and rating.
3.10.10	Fuses	Nos.	400% or minimum 100 no's for each type and rating
3.10.11	Racks for housing I/O & Processor Modules	Nos.	2(two) no. each type used in the system
3.10.12	Prefab interconnecting cables with connectors	Nos.	20% of total nos. used in the system or minimum 8(Eight) nos. whichever is more for each type.
3.10.13	Network communication cable with end connectors	Nos.	20% of total nos. used in the system or minimum 8(Eight) nos. whichever is more for each type.
3.10.14	I/O bus cables with connectors for remote I/O units	Nos.	2 nos. of each type & length
3.10.15	Fibre optic cable Converter / Deconverter	Nos.	2 nos.
3.10.16	Cooling Fans	Nos.	4 nos. for each cabinet
3.10.17	Loose Connectors	Nos.	10 nos. of each type
3.10.18	Colour TFT Monitor	Nos.	2 nos. complete set
3.10.19	Hard Disk Drive for the work Station	Nos.	2 nos. complete set
3.10.20	Key board , mouse / trackball with connecting cables and plugs	Nos.	2 nos. each type.
3.10.21	Printers Catriges	Nos.	4 nos. of each type
3.10.22	SMPS for printers	Nos.	2 nos. of each type/ rating
3.10.23	SVGA cards for printers	Nos.	2 nos. of each type
3.10.24	Key Board & Cursor control device	Nos.	2 nos. of each type
3.10.25	Complete Set of Operators Work Station	Nos.	2 nos. complete set
3.10.26	Terminal Block	Nos.	20% of total nos. used in the system for each type and rating.
3.10.27	Read-Write CD/DVD	Nos.	4 (four) no. complete set
3.10.28	Blank CD/DVD	Nos.	100 nos.
4.1	**HOISTS (for each type and rating)**		
4.2	Bearings for long travel wheels	Sets	4 sets
4.3	Bearings for gear boxes for each type of hoist	Sets	4 sets
4.4	Break liners for all the brakes	%	200% of total population of each type & size
4.5	Oil seals	%	200% of total population of each type,size rating
4.6	Brake springs for all brakes	%	200% of total population of each type,size rating
4.7	Wire ropes for hooks	%	200% installed on each hoist
4.8	Solenoid coils for brakes	Sets	4 sets
4.9	Overload relay for motors	Nos	4 Nos.
4.10	Limit switches for hoists and travel mechanisms	Sets	4 sets
4.11	Spare motors for hoists (for hoisting motion)	Nos	4 Nos.
4.12.1	**Long travel machinery**		
4.12.2	Gear wheel	Sets	2 sets
4.12.3	Internal clip	Nos	4 Nos.
4.13	Pinion	Nos	2 Nos.
4.14.1	**415 Volt Motor (Upto 30KW Rating)**		
4.14.2	Driving End & Non-Driving End Bearing	Sets	6Sets for each type and rating of Motor

S. No.	DESCRIPTION EQUIPMENT / PACKAGE	UNIT	Qty
4.14.3	Cooling Fan	Nos	4Nos. for each type and rating of Motor
4.14.4	Motor Terminal Block	Nos	10Nos. for each type and rating of Motor
4.14	Complete Set of Coupling	Sets	2Sets for each Application
4.15.1	**Control Panel/ Desk**		
4.15.2	Back-up panel mounted devices (Selector switches/ Push buttons/ Indicators etc.)	%	10% of installed capacity
4.15.3	Lamps/ LEDs	%	200% of the total quantity
4.15.4	Blank Tiles	%	20% of installed capacity
4.15.5	MCBs	%	20% of each type & rating
4.15.6	Fuses/ Fuse holder	%	200% of each type & rating
4.15.7	Push Button		
4.15.7.1	Complete assembly	Nos	10Nos for each colour
4.15.7.1	Contact Element (1NO + 1NC) Block	Nos	40Nos.
4.15.8	Selector Switch	Nos	20Nos. for each type and rating
4.15.9	Indicating Lamps complete assembly	Nos	20Nos. for each Colour and type
4.15.10	Mimic Lamps	Nos	20Nos. for each Colour and type
4.15.11	MCB	Nos	4Nos. for each type and rating
4.15.12	Door Limit Switch	Nos	4Nos.
4.15.13	Annunciation system		
4.15.13.1	Lamp Box with Facia & Lamps (LED type)	Nos	50Nos.
4.15.13.2	Hooter	Nos	2Nos.
4.15.13.3	Each type of PCB (for non-PLC driven system)	Nos	2Nos.
5	**Chain Pulley Block (for each type and rating, hoists)**		
5.1	Load chain wheel	Nos	2 Nos.
5.2	Load chain stripping fork	Nos	10 Nos.
5.3	Hand chain wheel	Nos	4 Nos.
5.4	Ratchet pawl	Nos	2 Nos.
5.5	Locking ratchet wheel	Nos	4 Nos.
5.6	Guide roller	Nos	4 Nos.
5.7	Brake disc	Nos	4 Nos.

Notes:

a)	Mandatory spares listed above are bare minimum requirement. In case any additional mandatory spares requirement is covered elsewhere in the tender specification apart from specified above, same shall be deemed to have been covered in bidder's scope of supply.
b)	"One (1) Set" and "One (1) set of each type & rating" is defined as total numbers as required for one complete replacement for one equipment of similar size & capacity.
c)	In case any spare indicated in the specification is "not applicable" for particular equipment, then suitable applicable alternate spare shall be supplied by the bidder without any financial implication.
d)	For quantities indicated in percentage, fractions are to be rounded-off to next higher integer.
e)	The quantity indicated shall be arrived based in the BOQ for the entire plant.Further, Stage # 1 (facilities for Unit # 1, Unit # 2, common to station as well as common for Unit #1 & 2) and Stage # 2 (facilties for Unit 3,4, & 5 and common for Unit #3,4,& 5) detailed break up of Mandatory Spares shall be submitted by bidder based on finalised BOQ arrived during detail engineering.

SECTION: I

SUB-SECTION: E

ANNEXURE-III

PAINTING AND COLOUR SCHEME

(AS PER SECTION C2C)

ANNEXURE-IV

LIST OF TOOLS & TACKLES

(REFER SUGGESTIVE PRICE FORMAT)

SECTION-I

SUB-SECTION-E

ANNEXURE-V

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE

(AS PER SECTION C2B)

SECTION-I

SUB-SECTION-E

ANNEXURE-VI

MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
1.	PE-V0-417-553-A001**	INSPECTION CATEGORISATION PLAN ALONG WITH SUB-VENDOR LIST FOR AIR CONDITIONING SYSTEM	2
2.	PE-V0-417-553-A002	QAP OF SCREW CHILLER PACKAGE	14
3.	PE-V0-417-553-A006	QAP OF AIR HANDILING UNIT	14
4.	PE-V0-417-553-A007	QAP OF PUMPS FOR AIR CONDITIONING SYSTEM	15
5.	PE-V0-417-553-A008	QAP OF COOLING TOWER FOR AIR CONDITIONING SYSTEM	15
6.	PE-V0-417-553-A009	QAP OF MOTORS FOR AIR CONDITIONING SYSTEM	15
7.	PE-V0-417-553-A010	QAP OF WATER SOFTENING PLANT	18
8.	PE-V0-417-553-A011	QAP FOR PLC	20
9.	PE-V0-417-553-A012**	HEAT LOAD CALCULATION FOR MAIN PLANT, ESP / VFD CONTROL ROOMS, FGD CONTROL ROOM #1&2, ADMIN BUILDING, DM PLANT CONTROL ROOM AND SERVICE BUIDLING ETC FOR AIR CONDITIONING SYSTEM	4
10.	PE-V0-417-553-A013**	OPERATION & CONTROL PHILOSPHY FOR AIR CONDITIONING SYSTEM	4
11.	PE-V0-417-553-A014**	PRESSURE DROP CALCULATIONS FOR CHILLED AND CONDENSER WATER PIPING FOR AIR CONDITIONING SYSTEM	10
12.	PE-V0-417-553-A015	TDS AND GA OF SCREW CHILLER ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	16
13.	PE-V0-417-553-A016	TDS AND GA OF WATER SOFTENING PLANT ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	18
14.	PE-V0-417-553-A018	TDS AND GA OF COOLING TOWER ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	15
15.	PE-V0-417-553-A019	TDS AND GA OF AIR HANDLING UNITS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	14
16.	PE-V0-417-553-A020	TDS AND GA OF CONDENSER AND CHILLEDWATER PUMPS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	15
17.	PE-V0-417-553-A021	TDS AND GA OF PAC / SPLIT AIR CONDITIONER	12
18.	PE-V0-417-553-A022	TDS AND GA OF MOTOR (PUMP, COOLING TOWER, AHU)	15

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
19.	PE-V0-417-553-A023	TDS OF INSULATION MATERIAL (DUCT INSULATION, DUCT LINING, PIPE INSULATION) FOR AIR CONDITIONING SYSTEM	12
20.	PE-V0-417-553-A024	TDS AND GA OF FRESH AIR FANS FOR AIR CONDITIONING SYSTEM	12
21.	PE-V0-417-553-A026	TDS AND GA OF AIR COOLED PRECISION AC UNITS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	12
22.	PE-V0-417-553-A027	TDS AND GA OF FOR 3-WAY MIXING VALVE FOR AIR CONDITIONING SYSTEM	8
23.	PE-V0-417-553-A028	TDS AND GA OF HEATERS AND HUMIDIFIER FOR AIR CONDITIONING SYSTEM	7
24.	PE-V0-417-553-A029	TDS AND GA OF FIRE DAMPER WITH ACTUATOR FOR AIR CONDITIONING SYSTEM	10
25.	PE-V0-417-553-A030	TDS AND GA OF VALVES (BALANCING VALVE, GATE VALVE, CHECK VALVE , Y ATRAINER) FOR AIR CONDITIONING SYSTEM	9
26.	PE-V0-417-553-A031	TDS AND GA OF SUPPLY / RETURN AIR DIFFUSER/GRILL FOR AIR CONDITIONING SYSTEM	8
27.	PE-V0-417-553-A032	TDS OF GI SHEET FOR AIR CONDITIONING SYSTEM	5
28.	PE-V0-417-553-A033	TDS OF PIPES FOR AIR CONDITIONING SYSTEM	5
29.	PE-V0-417-553-A034	TDS AND GA OF EXPANSION TANK, MAKEUP WATER TANK AND SOFT WATER TANK FOR AIR CONDITIONING SYSTEM	5
30.	PE-V0-417-553-A035	TDS AND GA OF FILTERS FOR AIR CONDITIONING SYSTEM	10
31.	PE-V0-417-553-A036	TDS FOR INSTRUMENTS (GAUGES-TEM, PR, LVL, PRES: SWITCH-TEMP,LVL, DP: SENSORS-TEMP, HUM ETC) FOR AIR CONDITIONING SYSTEM	12
32.	PE-V0-417-553-A037	TDS FOR PLC FOR AIR CONDITIONING SYSTEM	20
33.	PE-V0-417-553-A038**	PID FOR MAIN PLANT, SERVICE BUILDING, ADMIN BUILDING, ESP BUILDING, FGD CONTROL ROOM, DM PLANT ETC FOR AIR CONDITIONING SYSTEM	8
34.	PE-V0-417-553-A039	TYPICAL DETAILS DUCT FABRICATION DRAWING / SUPPORT / ERECTION. INSULATION OF DUCTING / PIPING & EQUIPMENTS CHILLED AND CONDENSER WATER PIPE ERECTION	7
35.	PE-V0-417-553-A040**	AHU ROOM LAYOUT WITH FOUNDATION DETAIL FOR UPS BATTERY CHARGER ROOM AT 32.5M	17
36.	PE-V0-417-553-A040A	AC DUCT LAYOUT FOR UPS BATTERY CHARGER ROOM AT 32.5M & SWAS ROOM AT 0 M	17
37.	PE-V0-417-553-A041**	AHU ROOM LAYOUT WITH FOUNDATION DETAILS FOR CONTROL ROOM AREAS AT 17M	16
38.	PE-V0-417-553-A041A	AC DUCT LAYOUT DRAWING FOR CONTROL ROOM AREAS FOR MAIN PLANT AT 17M	16

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
39.	PE-V0-417-553-A042**	AC DUCT LAYOUT DRAWING FOR ESP WITH AHU/PU ROOM LAYOUT WITH FOUNDATION DETAILS FOR INDR & OUTDR UNITS	18
40.	PE-V0-417-553-A043	AC DUCT LAYOUT DRAWING FOR FGD CONTROL BUILDING WITH PU ROOM LAYOUT WITH FOUNDATION DETAILS FOR INDR & OUTDR UNITS	16
41.	PE-V0-417-553-A044	AC DUCT LAYOUT DRAWING FOR DM PLANT CONTROL BUILDING WITH PU ROOM LAYOUT WITH FOUNDATION DETAILS FOR INDR & OUTDR UNITS	16
42.	PE-V0-417-553-A045	AC DUCT LAYOUT DRAWING FOR SERVICE BUILDING WITH AHU ROOM LAYOUT AND FOUNDATION DETAILS	18
43.	PE-V0-417-553-A046	AC DUCT LAYOUT DRAWING FOR ADMINISTRATION BUILDING WITH PU ROOM LAYOUT AND FOUNDATION DETAILS	18
44.	PE-V0-417-553-A047	AC DUCT LAYOUT DRAWING FOR OTHER AUXILIARY BUILDING WITH PU ROOM LAYOUT AND FOUNDATION DETAILS	20
45.	PE-V0-417-553-A048**	CHD & COND WATER PIPING LAYOUT WITHIN PLANT ROOM & UPTO VARIOUS AHU ROOMS, & COOLING TOWER AREA FOR POWER HOUSE	18
46.	PE-V0-417-553-A049	CHD & COND WATER PIPING LAYOUT WITHIN PLANT ROOM & UPTO VARIOUS AHU ROOMS, & COOLING TOWER AREA FOR SERVICE BUILDING	18
47.	PE-V0-417-553-A050**	CHD & COND WATER PIPING LAYOUT WITHIN PLANT ROOM & UPTO VARIOUS PAC ROOMS, & COOLING TOWER AREA FOR ESP BUILDING	18
48.	PE-V0-417-553-A051	CHD & COND WATER PIPING LAYOUT WITHIN PLANT ROOM & UPTO VARIOUS PAC ROOMS, & COOLING TOWER AREA FOR FGD CONTROL BUILDING	20
49.	PE-V0-417-553-A052	CHD & COND WATER PIPING LAYOUT WITHIN PLANT ROOM & UPTO VARIOUS PAC ROOMS, & COOLING TOWER AREA FOR DM PLANT CONTROL ROOM.	20
50.	PE-V0-417-553-A053**	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT FOR POWER HOUSE	12
51.	PE-V0-417-553-A054	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT FOR SERVICE BUILDING	12

S. NO.	DRAWING NO	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
52.	PE-V0-417-553-A055**	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT FOR ESP BUILDING	12
53.	PE-V0-417-553-A056	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT FOR DM PLANT CONTROL ROOM	16
54.	PE-V0-417-553-A057	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE FOUNDATION DETAIL OF ALL EQUIPMENT FOR FGD CONTROL ROOM	16
55.	PE-V0-417-553-A058	SPLIT/CASSETTE AC SCHEDULE ALONGWITH HEAT LOAD CALCULATION FOR AUXILIARY BUILDING	22
56.	PE-V0-417-553-A059	I/O LIST FOR AC SYSTEM	20
57.	PE-V0-417-553-A060	ELECTRICAL FEEDER LIST FOR AIR CONDITIONING SYSTEM	18
58.	PE-V0-417-553-A061	CABLE SCHEDULE FOR AIR CONDITIONING SYSTEM	22
59.	PE-V0-417-553-A062	PG/ DEMONSTRATION TEST PROCEDURE FOR AIR CONDITIONING SYSTEM	12
60.	PE-V0-417-553-A063	O&M MANUAL FOR AIR CONDITIONING SYSTEM	25
61.	PE-V0-417-553-A100	MANUFACTURING QUALITY PLAN WITH SUB VENDOR LIST FOR ELECTRIC HOIST.	14
62.	PE-V0-417-553-A101	MECHANISM SIZING CALCULATION WITH SCHEMATIC CIRCUIT DIAGRAM AND GA DRAWING FOR ELECTRIC HOIST, DSL ARRANGEMENT AND PAINTING DETAILS	15
63.	PE-V0-417-553-A102	MANUFACTURING QUALITY PLAN FOR MANUAL HOIST (CHAIN PULLEY BLOCK)	14
64.	PE-V0-417-553-A103	GA DRAWING FOR CPB WITH DETAIL BOM WITH PAINTING DETAILS	16

Drawing / Document indicated with ** are basis engineering documents.

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall

include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.: -

a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.

b) 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 labeled and included in BOQ / BOM in tabular form.

c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.

d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.

e) Drawings/ documents to be submitted for purchasers 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.

f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.

g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.

h) All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No.

i) 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.

j) Bidder to follow the following the drawing submission schedule:

k) 1st submission of drawings from date of LOI as per the submission schedule.

l) Every revised submission incorporating comments – within 7 days.

m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

SECTION-I

SUB-SECTION-E

ANNEXURE-VII

FORMAT FOR OPERATION AND MAINTENANCE MANUAL

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	**COVER PAGE**				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	**INDEX**				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	**DESCRIPTION OF PLANT/SYSTEM**				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
4.0	**COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)**				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	**OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR**				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	**MAINTENANCE GUIDELINES FOR PLANT PERSONAL**				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

SECTION-I

SUB-SECTION-E

ANNEXURE-VIII

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.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

    a. Rust preventive fluid (RPF)

    b. Rust protective paints

    c. Tarpaulin covers, in case of outdoor storage

    d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

    - Ingress of moisture and corrosion damages.
    - Damage to protective coating.
    - Open ends in pipes, vessels and equipment -
        - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

    - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
    - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere**. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.

ii **Semi-closed storage**. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.

iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

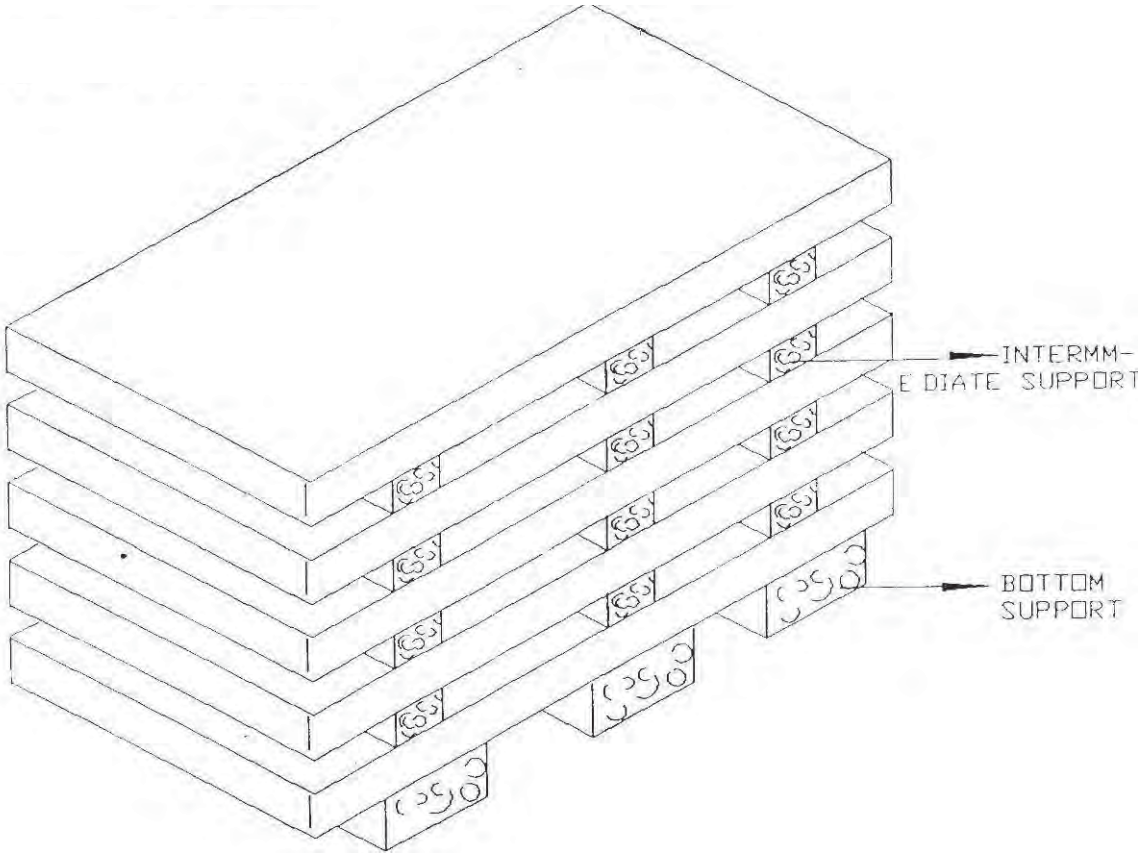


Figure – 1 – PLATE STACKING ARRANGEMENT

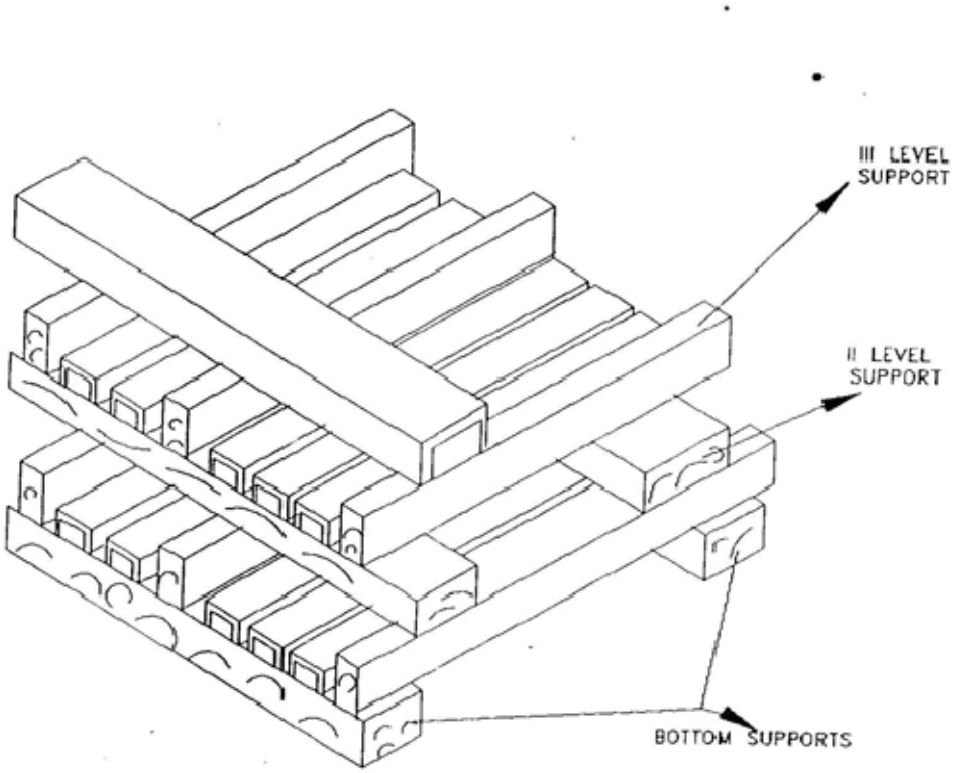


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

SECTION-I

SUB-SECTION-E

ANNEXURE-IX

PACKING PROCEDURE

(REFER SUB-SECTION C2-B)

ANNEXURE-X

CLARIFIED WATER ANALYSIS

Analysis of Clarified water

Table-1B

S.No.	CONSTITUENTS	As	CONTENT
1.	Calcium	$CaCO_3$	121.9 ppm
2.	Magnesium	$CaCO_3$	74.1 ppm
3.	Sodium	$CaCO_3$	184.4 ppm
4.	Potassium	$CaCO_3$	1.1 ppm
5.	Iron in Soln.	Fe	Nil
	TOTAL CATIONS	**$CaCO_3$**	**381.5 ppm**
6.	Bicarbonate	$CaCO_3$	134.8 ppm
7.	Sulphate	$CaCO_3$	80.9 ppm
8.	Chloride	$CaCO_3$	161.0 ppm
9.	Nitrate	$CaCO_3$	3.5 ppm
10.	Phosphate	$CaCO_3$	Nil
11.	Fluoride	$CaCO_3$	1.3 ppm
	TOTAL ANIONS	**$CaCO_3$**	**381.5 ppm**
12.	Reactive Silica	SiO_2	14.1 ppm
13.	Colloidal Silica	SiO_2	Nil
14.	Total Silica	SiO_2	14.1 ppm
15.	Nitrites	NO_2	Nil
16.	Total Hardness	$CaCO_3$	196 ppm
17.	Total Suspended Solid		15 ppm
18.	pH value at 25°C	-	8.0
19.	Turbidity		15 NTU

SECTION-II

SUB-SECTION-C1

SPECIFIC TECHNICAL REQUIREMENT – SWITCHYARD AREA WITH ANNEXURE – I, II, III & SWITCHYARD CONTROL BUILDING DRAWINGS

INTENT, SYSTEM DESCRIPTION, DESIGN CRITERIA AND SCOPE

1.0 INTENT OF SPECIFICATION

i. This specification covers design, manufacture, inspection, testing at bidder's and/ or his sub vendor's work(s), packing, transportation to site, handling at site, erection, testing and commissioning, final painting and carrying out acceptance tests at site of **Air - Conditioning System** as detailed in this section of specification for **Switchyard Control Building of 5 x 800 MW, YADADRI TPS, NALGONDA.**

ii. The requirement(s) specified under this section of this specification shall be considered as part of this section. In case of variance between sections, the requirement of this section shall prevail for switchyard scope. *TSGENCO contract specification provided as Annexure-III shall be referred strictly. Requirements of the same regarding system specification & applicable for switchyard part shall be provided by the contractor without any deviation.*

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

iv. The bidder shall be deemed to have understood completely all the tender drawings and documents and quoted accordingly.

v. The bidder has to note carefully the parameters, estimated capacities of equipment indicated and the tender drawing in the specification are only for guidance of the bidder. The system shall be designed as per relevant standards/ codes and exact capacities and quantities are to be estimated by the bidder. All such estimations and design calculations shall be submitted for Purchaser's approval.

vi. *Deviation:* In case of any deviation, the bidder shall indicate separately the deviations clause-wise with respect to the specification in the 'Schedule of Deviation' given in this specification. Deviations in any other form including clarifications / assumptions / etc will not be considered and it will be construed that the bid conforms strictly to the specification.

vii. The contract shall be on **Unit Rate Basis** for the package. In case of change in the input after placement of order the additions/ deletions to the scope shall be settled on the basis of unit rates agreed between the Purchaser and Contractor.

viii. During contract stage, quantities of various items of BOQ may vary to any extent and same unit rates will be applicable.

ix. The Purchaser, Consultant and Customer in this specification stand for BHEL, TCE and TSGENCO respectively. The successful bidder shall be referred to as Contractor.

1.1.0 AIR CONDITIONING REQUIREMENTS

1.1.1 Air Conditioning for Switchyard Control building

Air conditiong system for various areas of switchyard control building shall be provided as below:

Sl no.	Name of the Area	Dimensions of area (Sq. m)	AC Equipment	Equipment Capacity
1.	Control Room	20 m x 21 m	Air Cooled Precision Package AC Unit	3 x 30 TR*
2.	AC Plant Room	8 m x 10 m		
3.	Conference room	12 m x 10 m	Cassette AC Unit	3 x 4 TR
4.	Office room DE	6 m x 5 m	Cassette AC Unit	1 x 3 TR
5.	Office room ADE	4 m x 5 m	Cassette AC Unit	1 x 3 TR
6.	Staff room	5.5 m x 5 m	Cassette AC Unit	1 x 3 TR
7.	Electrical Test Lab	7 m x 5 m	Cassette AC Unit	1 x 3 TR

Air-conditioning shall be provided on continuous basis to maintain the specified inside conditions for above rooms in the building.

Adequacy of chosen AC equipments to cater both tonnage and CFM requirements of space to be cooled shall be ensured. Heat load estimates shall be prepared during detailed engineering to ensure the same; however minimum capacity of AC units for various rooms shall be as per the table above.

*Net cooling capacity of the each precision package AC unit shall not be less than 26.5TR after considering deration.

A. Precision Package AC (Air cooled)

DX type air-cooled precision package AC units shall be provided on 3 x 50% basis to cater the air conditioning heat load of control room.

DX type air-cooled precision package AC units shall be top discharge type designed specifically for high sensible heat ratio applications such as control room.

Air cooled Precision AC shall be top discharge type designed specifically for high sensible heat ratio applications complete with scroll compressors (suitable for R407C/ R410a refrigerant only), motors complete with suction and discharge shut off valves, high pressure cut out, low pressure cut out, evaporator fans with highly efficient EC motors and their controls, insulated SS drain pan electrode type humidifiers with controls, electric strip heaters and built in microprocessor based control panel thermally and acoustically lined powder**.**

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the

compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

One (1) No. fan and fin type air cooled condenser vapor inlet and liquid outlet connection for refrigerant, drain connection etc. One (1) no. evaporator coil and fan having direct expansion type copper tubes and aluminium fins. The evaporator fan shall be DIDW forward curved centrifugal fan.

The precision PAC unit shall have electronic expansion valve for superheat control.

The packaged AC units shall be kept in AHU room whereas condensing unit shall be kept outside nearby AHU room and the two are connected with suitably insulated copper refrigerant piping.

Outlet of all the package units shall be collected in a common plenum chamber through flexible canvass connection & volume control dampers. The conditioned air is then distributed to various AC areas through supply air duct along with diffuser (with volume control damper) running above false ceiling. The return air from all these areas shall be collected above false ceiling & shall be taken back to the AHU room. The return air to AHU room will be mixed with a fixed amount of fresh air before being circulated again.

On/ off trip indications for Precision AC unit components shall be available at the unit mounted micro-processor based local panel.

Equipment specification for Air cooled Precision package AC unit mentioned under Cl. no. 6.12.02 of TSGENCO specification for Air conditioning system shall be also be adhered to.

B. Ceiling Mounted Cassette Type Unit (Multi Flow Type)

The Cassette AC units will be complete with indoor evaporator unit, outdoor condensing units, hermetically sealed rotary/scroll compressor, filters, piping, valves, refrigerant strainer, Controls, instruments, control panel/ starter panels, vibration isolator pads and cordless remote control units. Outdoor unit shall comprise of hermetically sealed reciprocating/ rotary compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminum finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air. Outdoor units will be placed on outer wall or top of roof. The indoor units shall be Ceiling Mounted Cassette type. The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view. Unit shall have four way supply air grills on sides and return air grill in center. Removable and washable polypropylene filters shall be provided. They shall be complete with multifunction cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc. Copper refrigerant piping, wiring of indoor/outdoor unit shall be provided inline with distribution of AC units in various rooms and placement of outdoor units as per layout/ site conditions.

Suitable Voltage stabilizers shall be provided for each of the cassette AC units.

1.1.2 Design Criteria:

Ambient Conditions	DB in ºC	WB in ºC	
Summer	42.7	26.5	
Monsoon	30.9	26.5	
Winter	15.7	13.6	
Desired Inside Condition	Control Room $22^0C \pm 1^0C$ 55%±5% RH	Non Critical Areas $24^0C \pm 1^0C$ 60% RH	
Floor Area	As per control building layout		Sqft
Exposed glass area	As per control building layout		Sqft
Exposed wall area	As per control building layout		Sqft
Illumination Heat load	21.4		Watt per sq. m
Equipment heat load	31 (Control room)		kW
Occupancy	15		People
Fresh Air requirement	1.5		ACPH

- ✓ Office rooms, Conference rooms etc. shall be treated as non-critical areas.
- ✓ A design margin of 5% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area. An overall margin of 10% on calculated cooling load and CFM requirements shall be considered in selecting Plant capacity.
- ✓ Actual rating of precision package AC units shall be as per requirements of this specification after considering deration at design ambient of 45 deg. C.

1.1.3 SYSTEM DESCRIPTION

a) GSS duct shall be of lock forming grade, zinc coated conforming to IS 277 with coating grade of 180 g/m^2. The ducting thickness shall be as follows: -

Larger dimension of duct	Gauge
Up to 750 mm	24 G
From 751 to 1500 mm	22 G
From 1501 to 2250 mm	20 G
Above 2251 mm	18 G

b) Duct sizing and fabrication shall comply with requirements of IS 655. Air distribution velocity shall be 7.62 m/s. (max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.5 m/s. for the diffusers/ grills. In case of space constraint in certain areas velocity restrictions shall be relaxed.

c) Ducting shall include damper with control arrangement at each branch off and wherever necessary.

d) Supply air diffusers/ grilles (Frame and Louvers of Diffuser/ Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no volume control Damper.

e) Acoustic insulation 25 mm thick of first 6 m of ducting after AHUs but limited to plenum.

f) **Insulation**

S. N.	Surface	Insulation materiel	Insulation form	Thickness (mm)	Finish
1	AC Duct	Al foil faced Nitrile rubber	Roll / Slab	13	Al Foil Facing
2	Acoustic insulation of first 6 m of ducting after AHUs but limited to plenum	Nitrile rubber foam (140 Kg/Cu.m density)	Roll / Slab	25	Perforated Al Sheet
3	Refrigerant Piping	Al foil faced Nitrile rubber	Roll / Slab	39	Al Cladding

g) Necessary air balancing shall be achieved through volume control dampers in the ducts.

h) Strip heater shall be provided in the common plenum *in case* the same is not standard part of PAC unit. Heating requirements to be worked out during detailed engineering.

i) The pre- filters shall be of HDPE construction with G.I. frames of adequate thickness but not less than 20 SWG. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

j) The fine filters shall be having efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

k) The filters shall have G.I. frames of adequate thickness. The filters may be in panels of size about 600 x 600 for easy handling.

l) The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall not exceed 1.5 m/sec. these high efficiency filters shall be provided with differential pressure switch with alarm.

m) Motorized fire damper with sensors, control etc. at strategic locations, as required. Provision of manual overriding operation through latch shall also be kept with the Motorized Fire Damper.

n) Supply air diffusers/ grilles (Frame and Louvers of Diffuser/Grilles shall be of at least 20 SWG GI sheet and 22 SWG M.S. No grilles should by any chance make any rattling sound during continuous operation. All grilles shall match the decor of the space duly powder coated) with volume control dampers.

o) 1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for AHU Room. A differential pressure sensor shall be provided across each set of filters to initiate alarm when the pressure difference across the filters exceeds a pre-determined value, warranting cleaning/ replacement of filters.

P) MS brackets, M.S. frame & PVC drain piping for indoor & outdoor units respectively and fixing hardware like anchor bolts, nuts, fittings etc. as would be necessary for installation of above equipment shall be provided by the contractor.

1.1.4 OPERATION PHILOSOPHY

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

i. The Precision Air Conditioners shall have following operating controls:

- ON/ OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

ii. The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/ room mounted fire/ smoke detector through zonal fire panel.

iii. Interlocks

The system components shall be interlocked with one another in the following way:
The compressor shall not start unless:

- The condenser fans are running.
- The evaporator fans are running.

iv. The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

- **Equipment Specification shall be as per TSGENCO Technical specification attached as Annexure III to Sec-II, Sub Section C1.**

1.1.5 CONTROL PHILOSOPHY OF THE PRECISION AC SYSTEM OF SWITCHYARD CONTROL BUILDING

One no. PLC (RIO) panel with operator's engineering cum workstation (OWES) shall be provided in the switchyard control building for control and monitoring of switchyard Air conditioning system. This RIO panel will be an extended node to main PLC's of Air conditioning system situated in main plant local AHU control room of TG1 and TG2 buildings i.e. Unit 1 & 2, Stage#1 AHU Control Room & Unit 3 & 4, and Stage #2 AHU Control Room. This RIO panel and HMI shall derive supply from the same UPS provided to main PLC's. Necessary ACDB's (redundant) needs to be provided.

This RIO panel shall be networked with both stage PLC's of Air conditioning system in both stage#1 & stage#2 plants.

Fiber optic cable, patch cords, converters at both the ends shall be in contractor's scope. Field instruments redundancy shall be as per specification.

All the technical specifications of PLC RIO panel shall be same as that of PLC RIO panel provided in the main plant portion of this tender. These panels shall comply to **C&I Technical specification of AC system, in Sec-I, Sub Section C4 of this specification**.

1.1.6 ELECTRICAL REQUIREMENTS FOR AC SYSTEM

One (1) no. drawn-out type HVAC power distribution board (PDB) for extending power supplies to precision packaged units, fresh air fan, fire dampers and ventilation fans of cable spreader room, battery room & LT switchgear room shall be provided. The same will be located in AC plant room. Two nos. incomers of suitable capacity, 3 ph. 4-wire rating will be provided for HVAC power distribution panel with an electrical changeover switch.

PDB shall have suitable provisions to be compatible with plant PLC based control system for control & monitoring of vital AC signals from remote location.

20% spare feeders (of each type & rating) shall be provided in the PDB as per customer specification.

The purchaser will provide 3-ph. power supply points for cassette AC units.

Interlocking of PDB shall be done with Fire Alarm Panel to trip HVAC system in case of fire and actuate the fire dampers.

This panel in scope shall comply all concerned requirements of TSGENCO specification for 415 Switchgear provided as Annexure III to Sec-II, Sub Section C1.

PLC RIO panel to be placed in switchyard control room shall derive its DC supply from the UPS package meant for entire PLC system of the main plant.

All required instruments, transducers, switches required for control & monitoring of vital air conditioning system shall be provided.

1.1.7 MANDATORY SPARES (SWITCHYARD AIR CONDITIONING SYSTEM)

Following mandatory spares shall be provided:

S. No.	Item	Unit	Qty
I	**Mandatory Spares**		
A	Precision AC units		
1	Pre filters for PAC unit	Set	2
2	Bearing for outdoor unit and indoor unit	Set	2
3	Expansion valve	Set	2
4	Refrigerant gas in non-returnable cylinder	Lot	2
B	Cassette AC unit		
5	Vibration Isolators.	Set	2
6	Filters	Set	2
7	Expansion valve	Set	2
8	Fan - motor bearing for outdoor unit.	Set	2
C	**Electrical Spares**		
9	Control, Isolating and selectors switches (of each type & rating)	Set	2
10	MCB/ MCCB (of each type & rating)	Set	2
11	Indicating Lamps	Lot	2
12	Indicating Lamps cover of different color and holders	Lot	2
13	Push Buttons of various colors	Lot	2
14	Terminal Blocks	Lot	2
D	**PLC RIO Panel**		
15	Network cards, Communication Interface cards	10% for each type or but minimum 2 no.	
16	I/O Cards (Each type)	40% for each type or but minimum 2 no.	
19	Power Supply Modules & Power Packs for control system	10% for each type and range but min 2 no.	
20	Network Items (Network switch/ LIU unit/ Transceiver/ FO patch cord etc.)	20% of total nos. used for each type and model in the system or min 4(four) no. whichever is more.	
21	MCB (Miniature case circuit breaker)	2 Nos. for each type and rating.	
22	Fuses	200% or min 10 no's for each type and rating	
23	Racks for housing I/O & Processor Modules	1(One) no. each type used in the system	
24	Prefab interconnecting cables with connectors	10% of total nos. used in the system for each type.	
25	Network communication cable with end connectors	10% of total nos. used in the system for each type.	
26	I/O bus cables with connectors for remote I/O units	1 no. of each type & length	

2.0.0 SCOPE

The requirement(s) mentioned under this clause are indicative and minimum for the system. Any other item / service required to complete the work for safe and sound operation of system shall be provided and installed by the bidder at no extra cost to the Purchaser / Customer. The bidder may bring out such requirement(s) suitably.

2.1.0 SCOPE OF SUPPLY

2.1.1 Complete supplies for Air-conditioning system (as per clause no. 1.1.0)
The equipments and services to be furnished under this contract are detailed in a BOQ provided with this tender for reference. Bidders shall work out the actual requirement based on the building layout

enclosed with this specification. The items though not specifically mentioned but required for safe and satisfactory operation of the system will also be treated as included and the same shall be supplied at **NO EXTRA COST** to BHEL.

The Bill of Quantities shall be read in conjunction with the Instructions to Bidders, General and Special Conditions of Contract, Technical Specifications, and Drawings.
The quantities given in the Bill of Quantities are estimated and provisional, and are given to provide a common basis for bidding. The basis of payment will be the actual quantities of work ordered and carried out, as measured by the Contractor and verified by the Purchaser and valued at the rates and prices bid in the priced Bill of Quantities.

A rate or price shall be entered against each item in the priced Bill of Quantities. The cost of Items against which the Contractor has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Bill of Quantities.

The whole cost of complying with the provisions of the Contract shall be included in the Items provided in the priced Bill of Quantities, and where no Items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.

General directions and descriptions of work and materials are not necessarily repeated nor summarized in the Bill of Quantities. References to the relevant sections of the Contract documentation shall be made before entering prices against each item in the priced Bill of Quantities.

Miscellaneous items like hardware, fixtures etc. shall be deemed to be included under the relevant BOQ items and bidders shall consider the same while quoting for BOQ items.

2.1.2 Besides, the Bidder shall take a note of the following while preparing his offer:

a) Supply of power & control cables have been excluded from contractor's scope of supply. Bidders shall submit the requirement of power & control cables (cable size, type & quantity) for AC system along with their respective bids. BHEL will provide power & control cables to the vendor as free issue item. Contractor shall have to choose their cables from the available sizes *as listed in Annexure – I to Section-1* and contractor shall make necessary modifications in their equipment for termination of these cables.

b) ***Bidder shall choose make of materials from list enclosed in Annexure-II to this section. However final applicable make is subject to ultimate customer approval. Bidder can provide any other make that is not included in the list only if it is acceptable to ultimate customer without any cost implication to BHEL.***

c) Supply and laying of Fiber optic cable along with all accessories for networking of PLC (RIO) panel with main PLCs of different main plant control rooms is in contractor's scope of works.

d) Purchaser will lay two incomer cables upto contractor's HVAC PDB in AC Plant room. The contractor shall do termination of the same. Cabling (laying & termination) further to other equipments, panels etc and for control & interlocking of various equipments shall be in contractor's scope. The bidders in their offers shall include supply of cable accessories such as lugs, glands, cable tags & markers etc.

e) Necessary cable trays will be supplied on free issue basis to the contractor, however necessary hardware for fixing the same on walls or elsewhere shall be included by the bidders in their offers.

f) Earthing material viz. (GS flat 75 x 10, 50 x 6 & 25 x 3 mm) will also be supplied on free issue basis to contractor; however the bidders in their respective bids shall give requirement.

g) Instruments like differential pressure sensor, temperature transducers, switches etc shall be provided for completeness of the system wherever required as per TSGENCO specification.

h) Contractor shall submit valid Type test report for approval by Customer. Fresh type test of equipment is not envisaged. It is presumed that equipment offered is duly type tested.

i) In case the type test reports are found un-satisfactory, tests shall be carried out afresh by contractor without any additional cost implication to BHEL.

j) Bidder shall submit quality plan of the items of this system during detailed engineering stage in standard BHEL quality plan format for customer approval.

k) Obtaining, "As Built" certification from purchaser or Customer on applicable drawings. Completing documentation as per specification requirement shall be in contractor scope of services.

2.1.3 SCOPE OF SERVICES

2.1.3.1 Erection, Testing & Commissioning (ETC) requirements

i. The scope of ETC shall include receipt of material at site, safe storage of material, handling of equipment/material at site, erection of equipment /material at site including fabrication, equipment and system testing, commissioning of the entire system. The bidder shall arrange all material, consumables plus tools & tackles required for completion of ETC work.

ii. Conducting performance guarantee tests to the satisfaction of Customer/ Purchaser and handing over of the system to Customer / Purchaser. *Bidder shall submit the PG test procedure at the time of detailed engineering for approval by customer/ purchaser.*

iii. ***It is the responsibility of the contractor to abide to Guaranteed power consumption for Air conditioning system inline with the requirements of Sec-III, Sub Section 6 of the Complete plant portion of this tender****.*

iv. It is the responsibility of the contractor to maintain the system till it is handed over to customer / Purchaser.

v. Cables laying for incomers to the AC Power distribution board (PDB) shall be done by the purchaser. The contractor has to lay and terminate all the other power and control cables supplied under the present scope.

vi. The contractor shall do earthing of all installation under the present scope.

vii. All machinery - tools & tackles and consumables required for erection / commissioning of the system shall be arranged by the bidder.

viii. Bidder shall ensure that sufficient quantities of commissioning spares are made available for timely completion of commissioning of the system. The bidder shall furnish a list of Commissioning spares that will be brought by him. The unused commissioning spares shall be returnable to the Bidder.

ix. Piping from water tap-off to inlet of pan humidifier. The purchaser at one point near control room shall provide water tap-off.

x. Piping from overflow of pan humidifier & AC unit (disposal of condensate) to the nearest drain point.

xi. Cable laying & termination between Fire Alarm Panel (FAP) & PDB for HVAC system in order to switch off the system in case of fire.

xii. Laying & fixing of cable trays on walls or elsewhere. The bidder in their offer shall include necessary hardware for the same.

xiii. Painting of all the equipments shall be as per customer specification.

xiv. Refrigerant piping, liquid line valves, suction, discharge valves, HP gauge provision shall be as per the standards and customer requirement.

xv. After completion of erection and commissioning of the system, the bidder shall train site engineers of Purchaser/Customer so that they are fully conversant with both electrical and mechanical part of this package.

2.1.3.2 Civil Works

Major civil works such as room & foundations for various HVAC equipments shall be in purchaser's scope. However following shall be in contractor scope of services:

a. Wall openings at suitable locations for duct, refrigerant/ drain piping, Fresh Air unit shall be made by the contractor. Associated civil works such as grouting, filling up crevices/cut outs etc during installations of equipments shall also be in contractor's scope. Any other damage caused to civil works during ETC work of the equipment/system shall be made good to the original finish by the contractor at no extra cost to the purchaser.

b. Furnishing of details for construction of outdoor unit's mounting arrangement.

c. Providing necessary guidance to/ coordination with civil contractor so that appropriate sized / correctly located cut outs are made (by civil contractor) in false ceiling for installation of grilles / diffusers / return air.

However in case wall openings / cut outs have not been provided for either duct laying, louver fixing, or fresh air fan, the same shall have to be made by the Contractor.

d. Minor modifications, alterations in system installation as per customer's specific requirements shall be done without any extra cost to purchaser.

2.2 Exclusions

i. Supply of Cable trays for laying cables. Installation wherever required is in contractor scope.

ii. Supply of power and control cables. The bidder shall chose from the BHEL procured cables listed in Annexure-I to this section & furnish **quantity** and **type** of cables required complete system in their respective bids. Laying & termination is in contractor scope.

iii. Various rooms and foundations for locating air conditioning equipments.

iv. Supply & installation of false ceiling.

v. Underdeck insulation of the air-conditioned areas.

vi. Supply of GI flat for earthing of equipments.

2.3 Handing & Taking Over

It is the responsibility of the contractor to maintain the system till it is handed over. The system/ equipment before being handed over shall be subjected to successful run test as per approved PG Test procedure. The contractor shall rectify any defect noted during the period. This running test shall be in addition to the performance tests specified earlier.

2.4 Inspection & Testing

All equipments shall be inspected prior to dispatch in line with relevant IS, approved GTP/ drawing, technical specification & BHEL/ customer approved QAP.

NOTE

- **Following portions of Sec-I – Complete plant area of this technical specification is applicable for Sec-II- Switchyard area too as indicated in Index:**
  - **SUB SECTION C1 – Customer specification.**
  - **SUB SECTION C2, C2A Technical Requirement, C2B – Project specific general requirement, C2C – Painting specifications.**
  - **SUB SECTION C4 – Technical Specification (C & I Portion)**
  - **SUB SECTION D – Standard Technical Specifications**
  - **SUB SECTION E – Annexure V, VII, VIII, IX**

ANNEXURE - I

LIST OF THE CABLES PROCURED BY BHEL

2C x 2.5 sq mm PVC/ Copper, Armoured
5C x 4 sq mm PVC/ Copper, Armoured
5C x 2.5 sq mm PVC/ Copper, Armoured
7C x 2.5 sq mm PVC/ Copper, Armoured
14C x 2.5 sq mm PVC/ Copper, Armoured
19C x 2.5 sq mm PVC/ Copper, Armoured
2C x 10 sq.mm XLPE/ Aluminium, Armoured
4C x 10 sq.mm XLPE/ Aluminium, Armoured
4C x 16 sq.mm XLPE/Aluminium, Armoured
3.5C x 35 sq.mm XLPE/ Aluminium, Armoured
3.5C x 70 sqmm XLPE/ Aluminium, Armoured
3.5C x 300 sqmm XLPE/Aluminium, Armoured

Enclosures – **TSGENCO AC system spec, TSGENCO Switchgear spec, Switchyard Control building Architectural drgs.**

Annexure - II

AIR CONDITIONING SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS

[In line with ref. Cl. No. 2.1.2 b.]

SI. NO.	*ITEM / EQUIPMENT	SUB SUPPLIER
1.	PRECISION PACKAGE UNITS	STULZ / UNIFLAIR / EMERSON / BLUEBOX / CLIMADENTA
2.	SPLIT AC/ CASSETTE AC	VOLTAS / BLUE STAR / CARRIER / HITACHI / LG
3.	AIR FILTER	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER SPECTRUM / AIR TECH / PUROMATIC
4.	AXIAL FANS / F.A. FANS	FLAKT / KHAITAN / PATEL / NICOTRA / SARLA / KRUGER / MARATHON / C DOCTOR
5.	INSULTATION MATERIAL	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA /AEROCELL
6.	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
7.	FIRE DAMPER	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
8.	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW/ TSC /AIR MASTER/ CARYAIRE/RAVI STAR (SYSTEM AIR)
9.	STRIP HEATER	ESCORTS / RACOLD / DASPASS/ ALCO/ HEATCO /HOTSET
10.	PAN HUMIDIFIER	RAPID COOL/ HOTSET /ALCO
11.	THERMOSTATS	HONEYWELL / RANCO / PENN / DANFOSS / INDFOSS /JHONSON CONTROL /RANUTROL
12.	HUMID STAT	JHONSON CONTROL / HONEYWELL / PENN
13.	ANTI FREEZE THERMOSTAT	RANCO / HONEYWELL / PENN / DANFOSS /INDFOSS
14.	FLOW SWITCH	SWITZER / LEVCON / DK INSTRUMENT / SBEM / V. AUTOMATE/ SIEMENS
15.	FLOW METER	EUREKA / INSTRUMENTATION ENGINEERS PVT LTD / PLACKA /TRAC / FLOW STAR/ SCIENTIFIC DEVICE
16.	RH SENSOR/TEMP SENSOR	HONEY WELL /JOHNSON /SIEMENS / GENERAL INSTRUMENTS
17.	PLC BASED PANEL	SIEMENS / SCHENIEDER / ROCKWELL / GE INTELLIGENT / HONEYWELL AUTOMATION / ABB/ MITSUBISHI ELECTRIC
18.	OWS / PC	HP / COMPAQ / DELL / HCL / IBM / LENOVO
19.	UPS	HITACHI-HIREL / APC / DELTA / EMERSON / DB POWER / APLAB
20.	FIBRE OPTIC CABLE	BIRLA ERICSON / FINOLEX / AKSH FIBRE
21.	LT SWITCHGEAR	SIEMENS/ NITYA ELECTROCONTROLS/ JAKSON ENGINEERS/ L&T/ PYROTECH ELECTRONICS/ RSI SWITCHGEARS
22.	PRESSURE TRANSMITTER	ABB / ENDRESS + HAUSER (INDIA) / MOORE / SIEMENS / SMART INSTRUMENT BRAZIL / SBEM

* Make of the sub-components inside above listed items of AC system will be as per the approved data sheets/ drawings by the end client without any additional implication to BHEL.

Annexure III
to
Technical Spec. for Air Conditioning System of
Switchyard Control Building (Sec-II, Sub Section-C1)

VOLUME : IIID

SECTION-I

TECHNICAL SPECIFICATION
FOR
AIR CONDITIONING SYSTEM

THIS ANNEXURE IS TSGENCO TS FOR ENTIRE PLANT. BIDDER SHALL REFER THIS TS FOR THE PORTIONS RELEVANT TO AC SYSTEM APPLICABLE FOR SWITCHYARD SCOPE ONLY.

VOLUME: IIID

SECTION - I

AIR CONDITIONING SYSTEM

CONTENTS

CLAUSE NO.	DESCRIPTION
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2.00.00	SYSTEM DESCRIPTION
3.00.00	SCOPE OF WORK
4.00.00	CONTROL PHILOSOPHY
5.00.00	DESIGN CRITERIA
6.00.00	DESIGN, CONSTRUCTIONAL AND OTHER REQUIREMENT
7.00.00	SPECIAL TOOLS
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VOLUME: IIID
SECTION – I

AIR CONDITIONING SYSTEM

1.00.00 INTRODUCTION

1.01.00 The purpose of the system is to provide Air Conditioning System for the different areas of 1X800 MW Supercritical Thermal Power Plant, Stage – VII Unit #12 at Kothagudem Thermal Power Station, Telangana.

Various control rooms in power station, housing a group of sophisticated and precision control panels and desks call for controlled environment for proper functioning and for the comfort of working personnel.

2.00.00 SYSTEM DESCRIPTION

2.01.00 The air conditioning system shall cover the following areas as a minimum:

a. Power House Building including Control Room

i. Unit Control Room
ii. Control Equipment Room (CER)
iii. Shift Charge Engineers' Rooms
iv. Computer Room
v. Uninterrupted Power Supply (UPS) Room
vi. Steam and Water Analyzer (SWAS) Panel Room (Dry Panel)
vii. Excitation room
viii. AVR room
ix. Relay panel room
x. Other Office areas like Telephone Exchange Room, Conference Hall, library, Laboratory Rooms etc, if any, on the operating floor

b. Service Building

i. Maintenance Office areas, conference rooms, lecture rooms and any other areas needs Air Conditioning.

ii. AC plant control room (in Central AC plant equipment room proposed to be located in ground floor of Service Building)

c. ESP Control Room.

d. VFD Control Room (if applicable)

e. Ash Handling Plant Control Room

f. DM plant control room, office and Laboratory area.

g. Switchyard Control Room.

h. Chemical Laboratory Building.

i. Coal Handling Plant control room

j. Any other Local Control Rooms / Cubicles of different Auxiliary Buildings housing Programmable Logic Controllers (PLC) Panels and other Input / Output (I/O) modules

k. Rooms having the equipment required controlled temperature by nature for their operating feature.

l. Any other area requiring Air conditioning as per manufacturer's recommendation.

All the buildings described above shall preferably be provided with separate air conditioning systems because they may be far apart from each other.

2.02.00 For the Power House Building and the attached Service Building, one Common Central Chilled type Air Conditioning plant shall be provided with individual Air Handling Units / Fan-Coil Units (as applicable) for the Unit Control Room, Control Equipment Room, Shift Charge Engineer's Room, Computer Room, Uninterrupted Power Supply (UPS) Room, Excitation Room, AVR Room, Relay Panel Room, SWAS (Dry Panel) Room, all Laboratory Rooms and other Office areas, Telephone Exchange Room, Conference Hall, and Library etc, if any, on the operating floor.

2.03.00 Water Cooled Precision air Conditioners of 3 x 50% capacity shall be provided for the ESP Control room, VFD Control Room (if applicable), AHP Control Room, DM Plant Control Room and its associated office and Laboratory and Chemical Laboratory Building. Condenser cooling water for these Air Conditioners shall be supplied from main plant ACW system through Non-Chemical Water Treatment Device. Provision of a Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.

2.04.00 Air Cooled Packaged Units (Precision Type) will be used for air conditioning of the Switch Yard Control room and CHP Control room. Provision of a Fresh Air unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room.

2.05.00 Air cooled non duct able Split Air Conditioners shall be provided for Rooms / cubicles housing Programmable Logic Controllers (PLC) and other Input / Output (I/O) modules or any other area requiring for Air conditioning. Required no. of AC units of suitable capacity should be selected with 100% units as stand-by for AC areas having 24 hours operation. For AC areas with less than 12 hours operation, stand-by units may be avoided if multiple units are installed.

2.06.00 The systems described above are only minimum requirement. Any other area/areas, if felt by the Bidder himself or by the Purchaser/their consultant, or if demanded by the process/equipment should be air conditioned, shall be included in Bidder's scope of work.

2.07.00 The foregoing and subsequent clauses specify the equipment/system for general guidance only. Any other equipment and /or materials necessary to ensure safe and satisfactory erection, commissioning and operation of the plant shall be supplied.

2.08.00 The air conditioning requirement for different areas are as follows:

2.08.01 One Common Central chilled water Air Conditioning system consisting of 2x100% Packaged Screw type Chiller Units associated with 2 x 100 % capacity Chilled water pumps, 2 x 100 % capacity Condenser water pumps , 2 x 100 % capacity Cooling towers and controls & instrumentation to serve the Unit Control room, Control Equipment room, Computer room, UPS room, SWAS (Dry Panel) room and Shift Charge Engineer's room, AVR Room, Excitation Room, Relay Panel Room, Other Office areas, telephone exchange room, Conference Hall, library and Laboratory etc, if any, located in the Power House building and all the floors of the attached Service Building.

Clarified water shall be used as the make-up to cooling towers. This condenser cooling water will be treated through the Non-Chemical Water Softening Equipment installed in the common header of Condenser water pump outlets.

2.08.02 Unit Control Room & Shift Charge Engineer's Room, Computer Room, Control Equipment Room and UPS room in the Control Building will be served by at least 2 nos. each of 50% capacity AHUs located in the AHU Room.

For SWAS (Dry Panel) Room and Shift Charge Engineer's Room, AVR Room, Excitation Room, Relay Panel Room, Other Office areas, Telephone Exchange Room, Conference Hall, Library and Laboratory etc, if any, and the attached Service Building individual AHUs/ Fan Coil Units shall be provided. Each floor of Service Building shall have separate AHUs. For each room / area at least 2 nos. AHU/FCU shall be provided.

However, the combination of areas to be served by AHUs / FCUs will depend upon the actual layout when the building drawings will be finalized.

2.08.03 1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each AHU Room serving critical areas like Control Room, Control Equipment Room, UPS room, AVR Room, Excitation Room, Relay Panel Room, Telephone Exchange Room, Laboratory, etc.

For other non-critical areas like Office areas, Conference Hall, Library, various floors of Service Building fresh air will be inducted in the AHU room through the wall mounted rain protection cowl with bird screen and a volume control damper.

1 x 100% capacity Fresh Air Unit consisting of Air Inlet Louver with Bird Screen, Dry panel HDPE filters, Tube Axial Flow Fan with Drive Motor, Volume control damper, Supports and supporting structures etc. shall be provided for each PAC Room serving critical areas like ESP Control Room, VFD Control Room (if applicable), Ash Handling Plant Control Room, Chemical Laboratory Building, DM Plant Control Room, Office and Laboratory area, Switchyard Control Room and Coal Handling Plant Control Room etc.

Fresh air for small areas like SWAS room, AC plant control room, small office and control rooms fresh air will be inducted through door opening.

2.08.04 1 x 100 % capacity Electrode Type Humidifier with associated controls and accessories shall be provided in each AHU room serving critical areas of Power House Building.

2.08.05 Provision of Duct mounted Electric Strip heater and High Efficiency Filter shall also be kept with the common supply duct from the AHUs serving critical areas like Unit Control Room, Shift Charge Engineer's Room, Computer Room, Control Equipment Room, UPS Room. AVR Room, Excitation Room, Relay Panel Room, telephone exchange room, Laboratory, etc.

Duct mounted Electric Strip heater shall be provided with the common supply duct for non-critical areas like Office, Conference Hall, library, various floors of Service Building etc.

2.08.06 Smoke Evacuation system consisting of smoke exhaust fans with ducting, motorized isolating dampers and rain protection cowl with bird screen shall be located in AHU rooms serving control room and associated areas of Power House building.

2.08.07 Exhaust fans of required capacity & quantity to be provided for Central AC plant equipment room.

3.00.00 SCOPE OF WORK

Scope has been defined under subsequent Clauses.

3.01.00 Central Chilled Water Air Conditioning Plant

(Common for Power House Building and Service Building)

The central chilled water AC plant consists of the following equipment:

3.01.01 Two (2) Nos. (one as running and one as stand-by) Water Cooled Screw Chiller Unit of adequate capacity and each consisting of:

a) One(1) / Two(2) Nos. Screw Compressors (As per Manufacturer's standard).

Type: Rotary Screw type, hermetic/semi- hermetic, directly driven, R-134a duty.

Accessories include suction and discharge shut-off valves, discharge check valve, oil Separator, oil heater, HP, LP, Low oil level cutout, high winding temperature cutout through PTC sensors, Motor overload cutout, liquid Injection system, integrated pressure relief valve, oil service valve, Step less Automatic capacity control arrangement with automatic unloaded starting device, Anti Recycle device, Heater, Setting and Overhauling tools, foundation bolts, vibration isolating device etc.

Adequately sized Induction Motor (for the above compressors) suitable for 415V ± 10%, 3 phase, 50Hz ± 5% AC. AC Supply.

b) One(1) No. Refrigerant Condenser.

Type :Water cooled, horizontal, shell and tube R-134a duty & capacity to match the above compressor with integrally finned copper tubes with steel shell having adequate surface area to cater to the requirement of the above compressor & to provide sub-cooling by 2 Deg. C at least.

Design fouling factor : Not less than .0002 Hr. Sq. M. ^{0}C/Kcal (.001 Hr-Sq. ft ^{0}F/BTU).

Heat removal and water flow rate :To be calculated and furnished by be Bidder.

Accessories: Relief valve, vent connection with valve, De-scaling connection, charging connection, water flow switch, drain connection with valve. Thermo-well connections on water side, liquid trap etc.

c) One(1) No. Refrigerant Chiller.

Type : Horizontal shell and tube direct expansion/flooded type R-134a/water duty with copper tube having adequate surface area to provide superheating by 3 Deg.C.

Design fouling factor : Not less than 0.00013 hr-Sq. m. C/Kcal (0.00065 hr-Sq. ft. Deg. F./ BTU).

Heat removal and Water flow rate: To be calculated and furnished by the Bidder.

Accessories: Liquid and water connection provided with thermo-wells, water flow switch and pressure gauge connections.

At least 39 mm thick insulation of Aluminium foil faced Nitrile Rubber /XLPE or equal, with removable type insulated flange cover, water side drain connection with valve in every portion of the chiller isolated by baffle plates.

d) Piping & Auxiliaries : Common base frame for compressor, condenser, chiller unit fabricated of M.S. angles, channels etc. anchor bolts, nuts, hot gas piping, cold gas piping, liquid refrigerant piping all of seamless steel or ERW steel pipes, insulation of cold gas piping with minimum 39 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal liquid valves, muffler if needed, gauges and instrument piping, filters, drier, moisture indicator isolating valves etc. as may be required for safe and trouble free operation. The entire chiller package assembly shall be installed with spring type vibration isolation devices (One set for each chiller unit)

Equipment drain water connection with siphon and valves, fittings etc. up to the nearest drain point with proper insulation shall also be included.

e) Controls: Electronic expansion valve, solenoid valve in the refrigerant circuit, operating temperature sensor and anti freeze thermostat/ sensor.

Microprocessor based control panel of each chiller unit will provide safety against high & low refrigerant pressure, low oil pressure, freezing of chilled water, overload, winding heating and single phasing and phase reversal of compressor by means of high & low pressure transmitter, oil pressure transmitter, temperature sensors & transmitter, O/L relays, Thermistor relays, etc. and other safety Controls including Over/Under voltage and voltage unbalance protection, over/under current and current unbalance protection and others as per manufacturer's standard.

It will also provide capacity control by sensing low chilled water return temperature through operating temperature sensor and motorized sliding valve. Other safety devices like flow switches for the condensers and chillers, compressor unloaded starting device shall also be provided through Microprocessor based control panel. (One set for each chiller). Such Microprocessor based Control Panel shall be provided with 20% extra properly wired I/O units.

f) Oil and Refrigerant: First charge of refrigerant R-134a and oil for the above chiller units.

3.01.02 Condenser cooling water piping of MS ERW (heavy grade) complete with valves, fittings, hangers / supports. between cooling towers and condensers (of Screw Chiller Units) including the condenser cooling water pumps complete with valves, bends, strainers, fittings, instruments, hangers and supports etc. Equipment drain water connection and valves, fittings etc. up to the nearest drain point shall also be included. A single line diagram in this connection is to be furnished by the Bidder.

3.01.03 Chilled water piping connecting the chillers(of Screw Chiller Units), chilled water pumps and cooling coils of air handling units / FCUs and expansion tank, complete with valves, bends, strainers, fittings, instruments, hangers and supports, insulation etc. A single line diagram in this connection is to be furnished by the Bidder.

The insulation shall be at least 39mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal (Refer elsewhere for detailed specification of insulation). For Chilled water drain pipes the insulation thickness shall be at least 26 mm.

3.01.04 Make up water piping of medium class GI complete with fittings, hangers / supports from Make-up Water tank through booster pumps (1R+1S) to various points of consumption like cooling tower sumps, expansion tank and Humidifiers.

3.01.05 Two (2) Nos. (1 working + 1 Stand-by) Condenser Cooling Water Pumps to meet the requirement of the Central Chilled Water plant.

Type : Centrifugal, horizontally split casing / end suction type, single stage directly coupled to electric motor and mounted on a common base frame.

Speed : Preferably not more than 1500 rpm.

Capacity and Head : To be calculated and furnished by the Bidder.

Duty : Continuously running.

Accessories : Pressure gauges at suction and discharge, isolating valves, all integral piping, required for sealing, cooling etc. strainers, check valves, flexible coupling guard, foundation bolts and nuts etc. and other standard accessories as may be necessary for successful operation. Vibration isolators shall also be supplied. Condenser water pumps shall be provided with mechanical seals.

Motor for the above : Adequately sized TEFC, squirrel cage induction motor, suitable for 415 V ±_10%, 3 pH, 50 Hz ± 5% supply.

3.01.06 Two (2) Nos. (1 working + 1 stand-by) Chilled Water Circulating Pumps for all areas.

Type : Centrifugal, horizontally split casing / end suction type, single stage directly coupled to electric motor and mounted on a common base frame.

Speed : Preferably not more than 1500 rpm.

Capacity and Head : To be calculated and furnished by the Bidder.

Accessories : Pressure gauges at suction and discharge, isolating valves, all integral piping required for sealing, cooling etc. strainers, check valves, flexible coupling guard, foundation bolts and nuts, complete insulation with minimum 39 mm thick Nitrile Rubber /XLPE or equal with 24G aluminium sheet cladding. For the pumps, vibration isolators shall also be supplied. Chilled water pumps shall be provided with mechanical seals.

Duty : Continuously running.

Adequately sized, TEFC squirrel cage induction motor suitable for 415 V ± 10%, 3 Phase, 50 Hz ±5% supply for the above.

3.01.07 Two (2) Nos. (1 working + 1 stand-by) Cooling Tower Induced draft cross/counter flow type to meet the requirement of the Central Chilled water plant. Design Wet bulb temp. will be 27.6 ^{0}C with a approach (Maximum) of 4.0 ^{0}C.

Construction of various components will be as under:

Casing	:	FRP
Louver	:	FRP
Fill	:	PVC
Drift eliminator	:	PVC
Strainer	:	Brass wire mesh
Headers and pipe connection	:	G.I.
Basin	:	R.C.C./FRP
Nuts and Bolts etc.	:	Suitable corrosion resistant material i.e. G.I. or cadmium plated.

Accessories include supports, supporting structure, make-up water piping with float valve, drain connection with siphon and valve, over flow and quick fill connections etc.

3.01.08 Expansion Tank

The expansion tank shall be made of G.I or FRP and shall be of adequate thickness & suitably reinforced. It shall be complete with make-up connection with float valve, quick fill connection, overflow connection and drain connection with valve. The tank shall be provided with level gauge glass and shall be completely insulated with 6 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal. The capacity shall be selected based on 1.2% of circulated chilled water capacity. Filtered water shall be supplied as make-up.

3.01.09 Make-up water Tank

The Make-up water tank shall be made of G.I or FRP and shall be of adequate thickness & suitably reinforced. It shall be complete with make-up connection with float valve, quick fill connection, overflow connection and drain connection with valve. The tank shall be provided with level gauge glass. This tank will supply make-up water to Cooling towers, Expansion tank and

humidifiers. The tank size is to be designed based on capacity to hold water for 15 minutes of make-up water requirement for above.

3.01.10 Two (2) Nos. (1R+ 1S) Make-up Water Booster pumps.

Mono block type centrifugal pump to supply make-up water from the Make-up water tank to the Cooling towers, Expansion tank and humidifiers, each complete with drive motor, common base plate, isolating valves, non return valve etc.

3.01.11 One(1) No. on line Non-chemical water treatment equipment to suit the common condenser water header. The equipment shall be complete with flanges at ends and supports.

3.02.00 **Air Handling Units/Fan Coil Units with controls**

Number and individual capacities of Air Handling Units/Fan Coil Units should be calculated and furnished by the Bidder. Each A.H.U. shall consist of the following:

3.02.01 DIDW Centrifugal Fan having forward/backward curved blades and belt driven by TEFC squirrel cage Induction motor suitable for AC 415V ± 10%, 3 Ph, 50 Hz ±5% supply shall be provided. M.S. Scroll casing of the fan will be suitably painted.

Accessories include V-belts with pulleys, belt guard, supporting frame, volume control damper etc.

NOTE: For small FCUs single phase motors shall be used.

3.02.02 1 No. Cooling Coil will be provided in each AHU. The cooling coil will be chilled water circulating type.

Construction will be seamless copper tubes with aluminium fins, number of fins as per manufacturer's standard but not greater than five (5) per Cm. [thirteen (13) per inch].

Design fouling factor will be 0.00013 hr-Sq. m.- ^{0}C/Kcal.

3.02.03 Panel type dry HDPE filter having an efficiency of 90% down to 10 micron size particles will be provided. A differential pressure sensor shall be provided across the filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

3.02.04 AHU will have Double skin G.I casing (Sand witched panel with internal insulation of min. 25mm thick TF quality Expanded polystyrene/ PUF) with inspection facilities, supports made in a 16-G M.S. structure of sectionalized construction with one coat of rust proof anti-corrosive paints followed by two coats of final paint and complete with insulated SS drain pan, insulated drain piping etc. The AHUs shall be cabinet type with Fan section, Coil section and filter section. Adequate space between Filter section and Coil section shall be

kept for maintenance purpose and proper air flow. Fan section also shall have adequate maintenance space all around the fan and motor.

3.02.05 One set of operating controls consisting of motorized modulating 3-way mixing valve with cooling coils of AHUs and FCUs with temperature sensor, transmitter and actuator for controlling the flow of chilled water, will be provided. Small FCUs shall have multi-speed motor.

3.03.00 **Fresh Air System**

Fresh air unit for Control room areas and areas served by Precision air conditioners shall consist of a tube axial flow/centrifugal fan with drive motor, inlet louver with bird screen, dry panel HDPE filters, volume control damper, supports, supporting structures etc. 1 x100% capacity Fresh air unit shall be provided in each AHU room / PAC room. A differential pressure sensor shall be provided across each set of filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

For Fan coil unit, there shall be provision for suitable arrangement of fresh air intake from the nearest evaporative cooling units.

For Service Building and other non-critical areas, fresh air opening with air inlet louver and a volume control damper shall be provided in the AHU room.

3.04.00 **High Efficiency Filter**

High efficiency filter having an efficiency of 99 % down to 5 microns mounted in supply air duct is to be provided for air conditioning of all control rooms and allied area. A differential pressure sensor shall be provided across the filters to initiate alarm when the pressure difference across the filters exceeds a pre determined value, warranting cleaning /replacement of filters.

3.05.00 **Electrode Type Humidifier**

Electrode humidifier consists of high temperature Polypropylene water tank, electrodes, auto flash cycle activated on demand from the microprocessor based control system with humidity sensor, located in the AHU room for control room areas of Power House building. This Humidifier shall also be complete with make up connection with float valve, overflow connection and drain connection with valve.

3.06.00 **Electric Strip Heaters**

Electric strip heaters will be of adequate capacity mounted in supply air duct with thermostat, humidistat, air stat/safety thermostat and controlling temperature sensor etc. (For winter heating purpose and for monsoon reheat purpose.) for control room areas of Power House building.

Electric strip heaters will be of adequate capacity mounted in supply air duct with thermostat, air stat/safety thermostat and controlling temperature sensor etc. (For winter heating purpose) for various floors of Service Building.

3.07.00 **Smoke Exhaust System**

Smoke Evacuation system consisting of smoke exhaust fan with ducting and motorized isolating dampers with cowl & bird screen shall be located in AHU rooms servicing Control room areas of Power House building. The fan and motor shall be designed to withstand a temperature of 400 Degree C for 2 hours.

3.08.00 **Duct Work**

Duct work includes:

a) G. I. Duct having zinc deposition of at least 180 gm/m².

b) Damper with control arrangement at each branch off and wherever necessary.

c) All supply & return air grilles and diffusers made of extruded aluminum powder coated and complete with volume control dampers (for SA grilles/diffusers only) and supporting frames.

d) Flexible connections of rubberized canvas.

e) Hangers and supports.

f) Sealing compound and jointing gasket for ducts.

g) 13 mm thick Aluminium foil faced Nitrile Rubber /XLPE or equal or equivalent thermal insulation for the entire air conditioning ducting.

h) Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner outlet.

i) Motorized fire damper with sensors, control etc. at strategic locations, as required. Provision of manual overriding operation through latch shall also be kept with the Motorized Fire Damper.

3.09.00 **Water Cooled Precision Air Conditioners**
(Applicable for ESP Control room, VFD Control Room (if applicable), AHP Control Room, Chemical Laboratory Building and DM Plant Control Room and its associated Office and Laboratory)

Water Cooled Precision Air Conditioners shall be complete with scroll compressors (suitable for R-410/407c refrigerant) and water cooled shell and tube condensers, interconnecting refrigerant piping (duly insulated) between condensers and PAC units, evaporator fans with highly efficient EC motors and their controls, high efficiency filters, cooling coils with electronic expansion valve, electrode type humidifiers with controls, electric strip heaters, thermally and acoustically lined powder coated MS casing, insulated SS drain pan, insulated

drain piping, and built-in microprocessor based control panel.

Such Air Conditioners will be associated with air distribution system consisting of a GI duct - work as elaborated above, Non Chemical Water Treatment Equipment at the inlet to the condensers of PAC .Condenser cooling water will be fed to the condenser from the Plant ACW system.

3x 50% capacity Precision AC Units are to be provided each for each PAC room.

Provision of introducing fresh air into the PAC unit room shall be kept through Fresh Air Unit as described earlier.

3.10.00 **Air Cooled Precision Air Conditioners**
(Applicable for Switch Yard Control room and CHP Control room)

Air Cooled Precision Air Conditioners shall be complete with scroll compressors (suitable for R-407C / 410A refrigerant) and remote air cooled condensers, interconnecting refrigerant piping (duly insulated) between outdoor condensers and indoor PAC units, evaporator fans with highly efficient EC motors and their controls, high efficiency filters, cooling coils with electronic expansion valve, insulated SS drain pan electrode type humidifiers with controls, electric strip heaters and built-in microprocessor based control panel thermally and acoustically lined powder coated MS casing and insulated drain piping. Such Air Conditioners will be associated with air distribution system consisting of a GI duct - work as elaborated above.

3x 50% capacity Precision AC Units are to be provided each for each PAC room.

Provision of introducing fresh air into the PAC Unit Room shall be kept through Fresh air unit as described earlier.

3.11.00 **Air Cooled Non Duct-able Split Air Conditioners**
(Applicable for rooms/cubicles housing PLC and other I/O units, computer room and any other area requiring air conditioning)

Air Cooled Non Duct-able Split Air Conditioners shall be complete with hermetically sealed rotary compressors and air cooled condensers in the outdoor units with powder coated GI casing, built-in electrical items & supports and Indoor units housing dry panel type HDPE filters, cooling coils, evaporator fans with two speed drive motors, all encased in powder coated GI casings with swiveling type supply air grilles and decorative RA grilles and interconnecting refrigerant piping (duly insulated) between outdoor and indoor units and insulated drain piping, microprocessor based cordless remote control panel and 240V, single phase MCB with connecting cable for each split unit.

Required no. of suitable capacity should be selected with 100% units as stand-by for all rooms/ cubicles housing PLC and other I/O units/ computer room running for 24 hours.

For AC areas with less than 12 hours operation, stand-by units may be avoided if multiple units are installed.

3.12.00 **Electrical Work**

3.12.01 **One (1) 415 V Motor Control Centre (MCC)** for operation and control of the complete Central AC system required for the Power House Building and the associated Service Building. The MCC be shall be located in the central Air-Conditioning Plant room.

Each MCC shall be fed by 2 x 100% incoming feeders, which shall be located at either end of the panel.

3.12.02 **One (1) no. Local Starter Panel (LSP)** for each AHU room of Power House Building and attached Service Building. This LSP will house In-coming MCB, outgoing starter for all drives located in AHU room and MCB for heaters, humidifiers and FCUs.

3.12.03 **One (1) 415V Power Distribution Board (PDB**) each for supplying power to the PAC units of each Auxiliary Building.

Each PDB shall be fed by 2 x 100% incoming feeders, which shall be located at either end of the panel.

3.12.04 Non Duct-able Split units shall be fed from local distribution board / nearest power source available in the respective building.

3.12.05 All the Electrical items as described above shall be as per relevant volume of the technical specification on electrical work.

3.12.06 DDC Based Control Panel

I. Control, monitoring, operating and safety controls & interlocks, indication and audio-visual annunciation for all AC equipment of the Central Chilled Water Plant and AHU rooms shall be activated from central DDC based Control Panel located in the AC plant control room.

II. Power shall be fed to this DDC Panel from the MCC located in the Central AC plant room. This DDC panel shall be interfaced with the MCC, Individual Microprocessor based Control panels of Chillers and LSPs located in AHU rooms.

III. This DDC panel shall be associated with two nos. Workstations (Engineering & Operating).

IV. The DDC System shall consist of:

a) One (1) no. DDC panel housing Direct Digital Controllers for Central Air Conditioning System. The DDC panel shall be suitable for HMI interfacing directly with sensors, actuators and environmental delivery systems (i.e., all component equipment and accessories of AC system), controls and monitoring for the central AC System. This Control system along with one work station shall be complete with necessary software & Licenses (OS cum ES) for control

and monitoring of the Central AC System and generation of alarm list, report etc.

b) One (1) no work station complete with suitable Central Processing Unit (CPU) Key Board, Mouse and Video Display Unit (VDU) with 21 inches monitor.

c) Necessary battery back up for RAM for 24 hours continuous operation during power failure and necessary UPS and battery charger with minimum 30 minutes back up.

d) Necessary UPS Battery & Charger for DDC System back up shall be provided in the AC Plant Control Room.

e) Necessary interface hardware and software for interconnection with other system for two-way data transfer for information exchange. The data format, the exact number of points etc. shall be finalized during detailed engineering stage.

f) All other necessary hard wares to make the system complete and functional.

g) One Common Hooter for audio annunciation of any malfunction of AC equipment and systems.

h) System earthing and panel earthing of the DDC Panel.

i) The DDC shall have inbuilt PID function's for precise control of the process parameters.

j) The user friendly programming shall be done via Windows software.

k) Interlock list for equipment should be incorporated in the operator station.

l) Alarm List (Process & System), Event List , Different level of security.

m) The DDC Control system and its HMI shall have necessary Graphic user interface for display of the processes with indication of devices and instruments. In case of alarms the alarm indication window will be displayed on the screen to attract the attention of the operator and generate output for audio-visual annunciation.

n) Various controls and annunciations to be provided in DDC panel shall be as per clause no. 4.00.00: Control Philosophy.

3.12.07 Local Push Button Stations

Local Push Button Stations shall be provided for each drive motor and equipment (Cooling Tower Fan Motors, FCUs and Make-up Water Booster Pump Motors etc.), suitably located near drives and equipment of each AC system. LPBS shall consist of one no. emergency Red Stop P.B (pressed to latch and turn to release type) for each drive.

Local Push Button Stations shall be as per the relevant Volume of the electrical specification.

For Other detail VOLUME : II-F shall be referred to.

3.12.08 Local Distribution Board (240V)

Local Distribution Boards containing Switch / MCB for Non Duct-able Split Air Conditioners detail specification VOLUME : II-F shall be referred to.

3.12.09 Drive Motors

i) Motors shall be supplied with mounting and coupling hard wares such as base plate, coupling, coupling guard, anchor bolts and nuts, all hardware etc.

ii) Design ambient temperature of all motors for air conditioning system shall be 50°C.

iii) Motors shall have class F insulation but the temperature rise shall be limited to that of class B over an ambient temperature of 50°C.

iv) The motor nameplate kilowatt rating multiplied by the motor nameplate service factor shall be at least 15% greater than the driven equipment operating range maximum brake kilowatt.

v) Motors rated 30 KW and above shall be provided with space heater suitable for 240 V, 50 Hz, 1 Ph. AC.

vi) Motors rated below 250 watts shall be suitable for 240 V, 50 Hz, 1 Ph. AC. Motors rated 250 watts and up to 160 KW shall be suitable for 415V±10%, 3-Phase, 50Hz±5% AC.

vii) Motors rated above 110 KW shall be fed by Air Circuit Breaker and others of lower rating shall be fed by MCB/MCCB.

viii) All motor enclosures shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather proof construction.

ix) All drive motors shall be as per relevant Volume of the Electrical Specification.

3.12.10 All Power, Control and Instrumentation cabling as required and conforming to the requirement of relevant Volume of Electrical Specification.

3.12.11 Grounding of all electrical items as per relevant Volume of Electrical Specification.

3.13.00 Suspended Ceiling work with supporting grids, hangers etc. for all the air conditioned areas. The Suspended Ceiling shall be complete with 12mm thick GYPSUM board at various elevations including supplying, fixing snap grid

systems of approved manufacturer with 40 mm X 50 mm cross tees and 40 mm X 50 mm end channels including MS hangers, cleats, supports, turn-

buckles, ties placed around 1200 mm (Max.) centre to centre for forming frame work to support snap grid systems and lighting fixtures including all ancillary work at site like providing of various cut outs, holes, recess, trap door (removable panels), wherever shown, welding to reinforcement to hangers, if required, grouting of hangers and complete with all finish in super decorating manner, providing openings for lighting and air conditioning fixtures including painting of all structural with two coats of approved primer and final paint and also complete with all materials as per working drawings, and direction of engineers.

3.14.00 Under-deck Insulation work for all the air conditioned areas.Roofs of AC spaces are insulated with 25 mm thick EPS (Under-deck) for roofs not exposed to Sun and 50mm thick EPS (Under-deck) for roofs exposed to Sun.

3.15.00 **Supply, Erection, Testing and Commissioning**

3.15.01 Erection, testing and commissioning of all the equipment and accessories mentioned herein above including supply of all grouting pieces, all matching flanges, connecting flanges, valves and other fittings bolts, nuts, gaskets and supporting arrangement as required, are included in the scope of work.

3.15.02 Base plate and foundation plates including anchor bolts, nuts, loose fittings etc. for equipment and as would be necessary for erection and complete anchoring of steel materials for the pipes, hangers and supports for water chilling unit and other equipment, are to be supplied.

3.15.03 At least 39 mm thick Aluminium foil faced Nitrile rubber / XLPE insulation on refrigerant piping as required for the Precision type PAC units and 26 mm thick similar insulation for Non Duct-able Split units.

3.15.04 Supply, erection, testing and commissioning of all electrical drives and equipment mentioned herein above including supply erection, testing and commissioning of cables, cable trays, grounding of all drives and equipment for each AC plant and system as required for efficient and trouble-free operation and successful commercial operation, are included in the scope of work.

Erection, testing and commissioning of electrical drive motors and equipment shall be as per relevant volume of the specification.

3.16.00 **Consumables**

All consumables such as grease and lubricating oil for one year's trouble free operation after handing over, are to be included.

3.17.00 **Spare parts**

Supply of recommended spare parts for three years trouble free operation and maintenance is to be included.

3.18.00 **Special tools and tackles**

Supply of special tools and tackles including tool box required for operation, maintenance and overhauling of the system is to be done.

3.19.00 **Documents**

Drawing, data, characteristic curves and instruction manuals for the equipment and system as detailed herein after and as described in the relevant volume of the specification are required.

3.20.00 **Training of Purchaser's Personnel**

Contractor is to arrange for training of purchaser's personnel for operation and maintenance of the plant and equipment supplied.

3.21.00 **General**

Above clauses specify the equipment for general guidance only. Any other equipment and/or materials necessary to ensure safe and satisfactory erection, commissioning and operation of the plant shall be supplied.

4.00.00 **CONTROL PHILOSOPHY**

4.01.00 **Chilled Water Air Conditioning System**

The chilled water plant shall operate with 2 x 100% capacity Packaged Screw Chiller unit (1R+1S), 2x100% capacity (One no. working and one no. Standby), condenser water (CW) pumps, 1x100% capacity (One no. working and one no. Standby), chilled water (CHW) pumps, 2x100% capacity (One no. working and one no. Standby) induced draft-cooling towers.

All the equipment of this system shall be operated from the DDC system work stations located in the AC plant room. Furthermore cooling tower fans, make up Water Booster Pumps and FCUs shall also be operated from their individual local Push-button stations.

One no. Local starter Panel shall be installed in each AHU room which will feed power to all the AHU fans, motors of 3-way mixing valves of AHUs, Fresh air fans (wherever applicable), Smoke Exhaust fans (wherever applicable) and their motorized isolating dampers, Fire damper motors, Electric heaters and Humidifiers and FCUs of SWAS rooms, UPS Room. This equipment located in each AHU room and SWAS/ UPS Room shall be operated and controlled from the workstations through DDC system located in the AC Plant Room as well as from these Local Starter Panels.

FCU/s for AC Plant Control room shall be operated from the workstations through DDC system and from their local Push-Button stations.

The Packaged Screw Chilling units shall incorporate microprocessor based control panel, which will also be interfaced with the DDC system.

The Packaged Screw Chilling units can be started only when its associated cooling tower fans, condenser & chilled water pumps are in operation.

All the drives of the AC system shall be manually started / restarted through DDC from the work stations after any trip.

The chilled water system shall be provided with the following safety & operating controls:

(i) Operating Control:

Room temperature control with the help of modulating 3-way chilled water flow regulating valve with the cooling coil of AHUs / FCUs through the central DDC system, getting sense from the temperature sensor and associated transmitter placed in the return air path.

Chilled water temperature control based on the room load with the help of operating temperature sensor and controlling through compressor's automatic unloading mechanism for screw chillers through the built-in Microprocessor based control panel of Packaged Screw Chiller. This control shall also be possible through the central DDC system.

Room RH control with the help of humidifiers (if required) & duct mounted re-heaters through the central DDC system getting sense from the RH & Temperature sensors and their associated transmitters placed in the return air path inside AHU rooms.

(ii) Safety Control:

The chilled water system shall be incorporated with the following safety controls and interlocks:

High discharge pressure cutout (HP).

Low suction pressure cutout (LP).

Low oil level cutout

High winding temperature cutout
through PTC sensors

Low chilled water temperature cutout by anti-freeze thermostat /temperature sensor for Screw chiller.

Cutout due to low flow of chilled water & condenser water by flow switches.

Cutout due to overload of all drive motors.

High air temperature cutout by safety thermostat / temperature sensor for duct mounted electric heaters.

Low cooling tower sump water level cutout for CW pumps. (Alarm for low water level in expansion tank & humidifier as applicable shall be provided).

Stopping of AHU fans in case of fire in the respective zone through the central DDC system.

Short circuit protection.

Closing of fire dampers at the air supply duct from AHUs in case of fire with the sense from room mounted fire/smoke detector through zonal fire panel and the DDC system.

Heater for compressors, which will be energized during compressor idling time. This safety control shall be actuated through the built-in Microprocessor based control panel of each Screw chiller.

Safety controls of Screw chillers will also include Over/Under voltage and voltage unbalance protection, Single phase & Phase reversal preventor, over/under current and current unbalance protection and others as per manufacturer's standard.

(iii) Interlocks:

The system components shall be interlocked with one another in the following way:

The Screw Compressor shall not start unless:

At least one cooling tower fan is running.

At least one condenser water pump is running.

At least one chilled water pump is running.

The duct mounted electric strip heater shall not be energized unless the respective AHU fans are running.

All the above Interlocking shall be actuated through the DDC Panel.

On-Off-trip status for all the drives, electric heaters & humidifiers (if required) shall be available at the work stations of the DDC Panel located in the respective AC plant rooms.

Motors of fire dampers provided in supply air duct of AHU shall remain energized in normal condition to effect opening of dampers. In the event of fire, the motors of fire dampers will be de-energized and the damper will close due to spring action, the relevant AHU fan motors will be tripped at the same time. These dampers shall be operated through the DDC Panel getting signal from relevant duct mounted smoke detectors / fire alarm panel.

Provision for one common audio annunciation for any kind of malfunctioning in AC plant shall be kept through a hooter located in the AC Plant Control Room and suitably interfaced with the DDC Panel.

The control system shall comprise central DDC Panels with two workstations located in the AC Plant control room.

The basic function of the system is as follows: -

To closely control and monitor inside temperature and humidity condition inside the air-conditioned spaces.

To optimize / minimize energy consumption by automated operation.

To provide centralized monitoring and control for various mechanical facilities including sequential start / stop of the whole AC system.

To generate maintenance data and alarms.

To maintain records of plant operation.

Programmed start / stop of individual AHU as per operating requirements and for maintaining the room temperature / RH by controlling the 3 way mixing valves at chilled water line, humidifier and duct heater.

Programmed start / stop of individual FCU as per operating requirements and for maintaining the room temperature by controlling the 3 way mixing valves at chilled water line.

Safe and reliable operation, supervision & control, alarm & event management and optimization, maintenance management of the entire AC system shall be accomplished with the DDC system.

The DDC system shall be interfaced with:

The Air Conditioning MCC.

The Microprocessor based control panels of Screw Chiller.

The LSPs located in each AHU rooms.

The Temperature and RH sensors and their associated transmitters located in the AHU rooms.

The Temperature sensors located in the rooms served by FCUs.

The zonal fire panels/ duct mounted smoke detectors.

The two work stations and the Hooter.

4.02.00 **Air Conditioning System with Water-Cooled Precision Air Conditioner**

This system will operate round the clock for ESP Control Rooms, VFD Control Room (if applicable), Ash Handling Plant Control room, DM Plant Control room with associated office and Laboratory.

Water Cooled Precision Air Conditioners of 3x50% (Two nos. working and one no. Standby) capacity shall be provided for ESP Control Rooms, VFD Control Room (if applicable), Ash Handling Plant Control room, DM Plant Control room with associated office and Laboratory.

Condenser cooling water for the Precision Air Conditioners shall be supplied directly from the ACW system.

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

(i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Superheat control by means of electronic expansion valve, wherever applicable.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

(ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.

- Low condenser water flow cutout.

(iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

a) Condenser water flow is low.

b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

4.03.00 **Air Conditioning System With Air-Cooled Precision Air Conditioner**

This system will operate round the clock for Switch Yard Control room and Coal Handling Plant Control Room.

Air Cooled Precision Air Conditioners of 3x50% (Two nos. working and one no. Standby) capacity shall be provided for Switch Yard Control room and Coal Handling Plant Control Room.

The Precision Air Conditioners shall be operated from the respective unit mounted microprocessor based control console.

(i) Operating Control

The Precision Air Conditioners shall have following operating controls:

- ON / OFF thermostatic control of the compressor of Precision Air Conditioners to maintain the desired room temperature.
- Superheat control by means of electronic expansion valve, wherever applicable.
- Room RH control (wherever required) with the help of humidifier & heater installed within AC units getting sense from the humidistat placed in the return air path.

(ii) Safety Control

The compressor of each Precision Air Conditioner shall be incorporated with the following safety controls and interlocks:

- High refrigerant pressure cutout.
- Low refrigerant pressure cutout.
- Low Oil Pressure Cut out (if applicable).
- Cutout due to overload of all drive motors.
- Stopping of evaporator fans in case of fire in the respective zone.
- Closing of fire dampers at the supply duct from Precision Air Conditioners in case of fire with the sense from duct/room mounted fire/smoke detector through zonal fire panel.

(iii) Interlocks

The system components shall be interlocked with one another in the following way:

The compressor shall not start unless:

a) The condenser fans are running.
b) The evaporator fans are running.

The electric strip heater shall not be energized unless the respective evaporator fans are running. The Strip heaters will trip with the help of safety thermostat in case the temperature of air at the downstream side of the heaters exceeds a pre-determined value.

On-Off-trip indications for all the drives & electric heaters shall be provided at the unit mounted microprocessor based control console.

4.04.00 **Non Duct Able Split Air Conditioners**

Non-duct able Split air-conditioners will be controlled from the unit mounted Control panel or from the cordless hand operated remote.

5.00.00 **DESIGN CRITERIA**

5.01.00 The design outside conditions are taken from Meteorological Station at Khammam nearest to Kothagudem Thermal Power Station area.
For designing of the equipment, outdoor conditions shall be considered as follows:

Outdoor design condition	:	Summer	:	42.6 Deg. C (DB), 26.6 Deg. C (WB)
		Monsoon	:	30.9 Deg. C (DB), 25.8 Deg. C (WB)
		Winter	:	20.8 Deg. C (DB),

18.4 Deg. C (WB)

Inside design condition	:	22.0 Deg. C ± 1 Deg. C DB & RH 55 % ± 5% for critical areas like control room, control equipment rooms, computer room, UPS rooms, AVR rooms etc. 24.0 Deg. C ± 1 Deg. C DB & RH not exceeding 60% for the non-critical areas like offices, conference room, SWAS room, etc. and the areas served by split air conditioners. For service building the inside conditions shall be 24.0 Deg. C ± 1 Deg. C DB & RH not exceeding 60% in all seasons except winter. In winter a DB temperature of 22.0 Deg. C shall be maintained.

Any equipment/process demanding any other (less) temperature shall be provided with.

Floor area	:	As per actual layout
Roof area	:	As per actual layout
Glass area	:	As per actual layout. All windows in the Air Conditioned shall be provided with light coloured Venetian blind
Lighting load	:	21.4 Watt/sq.m (or actual) for all areas except shift charge engineer's room & service building where 16 watt per sq.m (or actual) shall be considered.
Occupancy	:	One (1) person in 12 sq.m (or actual)
Equipment/Panel load	:	As actual.
Solar load	:	Solar and transmission load through walls, roofs, doors, windows, glazing, floors etc. should be considered.
Ventilation Air	:	Fresh air at the rate of 1.5 air changes per hour for the control rooms and 1 air change per hour for office areas or at least 34 Cu. M/Hr. per person, whichever is higher, should be considered to achieve pressurization of air conditioned space and to meet the ventilation requirement of occupants.

Other loads : Heat load due to AHU fan motor, duct friction etc. shall be considered while finding total heat load.

Plant sizing : Plant sizing is to be done by allowing 5% margin on total sensible and latent heat calculated on the basis of above design considerations. An overall margin of 10% on calculated cooling load shall be considered in selecting Plant capacity.

All Condenser cooling water pumps and chilled water pumps, AHUS and FCUS shall have further, 10% margin on their flow capacities.

Insulation : Roof over AC space exposed to sun will be provided with 50 mm thick expanded polystyrene or equivalent. Roof over AC spaces not exposed to sun will be provided with similar insulation of 25mm thickness.

5.02.00 Individual air handling equipment shall be provided for individual facilities. Chilled water flow control valve (3-way), strip heater and electrode humidifier are provided for maintaining inside conditions.

5.03.00 All water piping for the make-up at cooling tower sump, Electrode humidifiers, Expansion tank and Make-up water tank etc. shall be provided by the bidder. Such make-up water piping shall be taken from the nearest clarified water header.

5.04.00 Electric power supply will be 415V ± 10%, 3 phase, 50 Hz. ± 5% A C.

5.05.00 The basic proposal by the bidder shall be for equipment strictly according to the technical specification. The location of air conditioning equipment, layout of ducting, piping etc. shall be designed by the bidder and approved by the Consultants/Owner.

5.06.00 The bidder shall satisfy himself regarding the refrigerating capacity required for maintaining the end conditions inside AC spaces before submitting the offer. For this purpose, the basis of computing air-conditioning load mentioned earlier is to be referred. The bidder shall have to guarantee the end conditions mentioned earlier.

5.07.00 **Codes and Standards**

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below :

IS-659 : Safety code for air-conditioning

IS-660 : Safety code for mechanical refrigeration

ASHRAE-23	:	Standard method of testing and rating [67 Standards] air conditioner.
AR1-450-6	:	Standards for water cooled refrigerant Condenser.
ASME Sec. VII	:	Unfired pressure vessels
IS-4503	:	Shell and tube type heat exchanger.
ASHRAE 22-72	:	Method of testing for rating water cooled refrigerant condenser.
ANSI-8-31.5	:	Refrigeration piping.
ANSI-8-9.1	:	Safety code for mechanical refrigeration.
AR1-410	:	Standard for air cooling and air heating coils.
AR1-210	:	Standard for unitary air conditioning equipment.
IS-3588	:	Specification for electrical axial flow fans.
AMCA-210	:	Methods of performance test for fans.
BS-2831	:	Methods of test for air filters used in AC and general ventilation.
IS-4671	:	Expanded polystyrene for thermal insulation purpose.
IS-702	:	Industrial bitumen.
IS-1239	:	Heavy class Pipes for sizes upto 150 mm dia.
IS-8188	:	For Water conditioning.
IS-325	:	3 phase induction motors.
IS-4029	:	Guide line for testing 3 phase induction motor.
IS-210	:	Specification grey iron casting.
IS-2062	:	Structural steel
AMCA -Bulletin No. 210	:	Standard code of testing centrifugal and axial flow fans
IS-2825	:	Code of practice for welding mild steel
IS-2676	:	Dimensions for wrought aluminum and aluminum alloy sheets and strips.

ASHRAE Code	:	for various filter
IS-655	:	Specification for metal air ducts
BS-4735	:	Horizontal Burning for XLPE insulation
BS- 4370 Part-1	:	Dimensional Stability for XLPE Insulation
ASTM D 1056	:	Water Absorption for XLPE Insulation

Pump design and testing should correspond to the procedure mentioned in IS-1520.

5.08.00 The refrigerant for Split units shall be R-22 as per ARI designation.

5.09.00 For requirements of materials of construction, 5.00.00 of this section shall be referred to.

5.10.00 **Special Note**

In case any discrepancy is found between requirements of this section and those mentioned in other sections, stipulations of this section shall prevail.

6.00.00 DESIGN, CONSTRUCTIONAL AND OTHER REQUIREMENT

6.01.00 General Instruction to the Tenderer

6.01.01 The Tenderer shall refer only to those of the following clauses which are applicable for this particular project as detailed in clause 1.00.00 and 2.00.00 of this specification. The clauses which are not applicable for this project shall be ignored.

6.02.00 General Design, Constructional and other Requirement

6.02.01 All the equipment shall be capable of withstanding the stresses which may be experienced during normal operation and test.

6.02.02 All the equipment shall be designed to permit inter-changeability of parts and ease of access during inspection, maintenance, installation and repair of various parts.

6.02.03 All parts subject to substantial temperature changes shall be designed and supported such as to permit free expansion or contraction without resulting in leakages, harmful distortion, misalignment or play.

6.02.04 Proposals for repair or any similar operations involving the plugging, welding, boring or addition of metal to the original castings shall be submitted to the Purchaser/Consulting Engineer and approval shall be received before any such

work is carried out. Drawing showing details and locations of such modifications shall be submitted to the Purchaser/Consulting Engineer for his records.

6.02.05 All equipment shall be heavy duty type suitable for installation in heavy industries and for long period of uninterrupted service.

6.02.06 All materials used shall conform to the specification and shall be new and first class in all respects.

5.02.07 Anchor bolts, nuts and seating steel work shall be supplied with the equipment. Only hexagonal nuts shall be used for holding down the equipment, with proper lock nuts. All bolt holes shall be spot faced for nuts. In specific cases where not necessary, spot facing may be omitted.

6.02.08 Casting and welding shall conform to their respective specifications and shall be free from flaws and objectionable imperfections, machined true and in a workmanlike manner.

6.02.09 The separate pieces of equipment shall be marked with unit number The assembly drawings shall indicate part number of each equipment and unit number for easy correlation.

6.02.10 Coupling guards and belt guards shall be furnished as applicable.

6.02.11 All equipment, ducts, pipes, controls etc. shall be fully treated against corrosion and sealed against moisture, sand and dust ingress.

6.02.12 All plant including ducts and pipes as well as machines shall be vibration isolated, or otherwise treated so that :

- No excessive vibration is felt in the floors or walls of the rooms served by any machine.
- The mechanically induced vibration levels in floors, walls and ceilings of rooms are sufficiently small as to limit the radiation of the sound level to the rooms within acceptable levels.

6.03.00 **Packaged Screw Chillers**

A. Refrigerant Compressors (Twin Screw Type)

I. The compressor may be designed either for direct or for indirect drive.

II. The compressor assembly shall be adequately designed for minimum vibration and noise disturbances.

III. The shaft seal shall be of proven design.

IV. All safety devices against high-pressure refrigerant, low-pressure refrigerant and low oil pressure shall be provided, High winding temperature through PTC sensor. The compressor units must be provided with oil pressure regulator.

V. The horsepower of the compressor motor shall be sized for 115% of maximum rated power required for the unit including the drive loss.

VI. The compressors shall be provided with built-in-unloaded starting device. The compressor shall have automatic capacity control device preferably built-in-type to match reduced refrigeration load.

VII. Capacity control must be achieved by use of slide valve, which provides fully modulating capacity control from 100% to 10% (20%, at least) of full load. The slide valve shall be actuated by oil pressure controlled by external solenoid valves.

VIII. The oil separator should be effective enough to incur gravity drop out of oil from the refrigerant gas before it enters the condenser.

B. Heat Exchangers (Condensers and Chillers)

I. All condensers shall be of shell and tube type with water in the tubes and refrigerant in the shell.

II. All chillers for chilled water plant shall also be shell and tube type with water either in tubes or outside the tubes.

III. The heat exchanger shall be designed for a minimum working pressure of 10.5 kg/cm^2 gauge on the water side and 11.3 kg/cm^2 on the refrigerant side and shall generally conform to the latest ASME CODE for unfired pressure vessels Section- VIII. The design pressure shall have a reasonable margin over the maximum working pressure.

IV. The average velocity of water in tubes shall not be more than 2.5 m/sec.

V. Water heads or refrigerant heads of the heat exchangers shall be as not to allow leakage of fluid from one pass to the other.

VI. Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating.

VII. The overall fouling factor for the condensers and chillers shall be 0.0002 and 0.00013 $Hr.M^2\ ^oC$ /K Cal respectively.

VIII. The condensers shall be designed to provide at least 2 ℃ sub cooling of refrigerant under rated design condition. The water chillers also shall be designed to superheat the refrigerant by at least 3 ℃ under rated design condition.

IX. Testing and other design feature of the heat exchanger shall meet the requirements of TEMA Class-C heat exchangers or approved equal.

X. The heat exchangers shall have open able water boxes for ease in maintenance.

XI. The tube for water chillers shall be of deoxidised copper with or without integral fins. The tubes for the condensers shall also be copper with integral fins. The tube wall thickness at any point shall not be less than 18 SWG.

XII. The baffle plates and the tube sheets shall be made of steel. The shell shall be made up of seamless tube or shall be fabricated from flange quality steel plate (ASTM-A285 Grade-C). The tube support plates shall be made of flange quality carbon steel plates and shall be as per TEMA Standard.

XIII. The heat exchangers shall be provided with vent valve, relief valve, and/or safety fusible plug on refrigerant side and vent valve and drain valve on water side (at every section of the baffled shell of heat exchanger).

XIV. The tenderer shall quote packaged units having compressor, condenser and chiller assembly together in a single framework and mounted on a common base plate. Provision for refrigerant charging and chemical cleaning of water tubes shall be provided.

XV. Each heat exchanger shall be provided with water flow switch. This shall be interlocked with the control of the individual refrigeration system/corresponding compressor drive.

XVI. All the heat exchangers shall be provided, with standard connections like thermo wells, inspection valve and antifreeze thermostat / temperature sensor and external equaliser connection for expansion valves for chiller. Insulation shall be terminated in such a manner that it will not be damaged during removal of bolts, covers etc. Separate covers similar to flange covers shall be constructed to facilitate easy removal.

6.04.00 **Water Pumps**

6.04.01 Each pump shall be of horizontal split casing / end suction centrifugal type, directly coupled to electric drive motor and mounted on a common base plate. Pumps having motor of 5 HP capacity or below can be of mono-block construction, provided its materials of construction are as mentioned below and motor is as per desired motor specification.

The pump shall be complete with casing, impeller, renewable type wearing rings, shaft, shaft sleeve, bearings, stuffing box, Mechanical Seal (if applicable), cowlings, base plate etc. as applicable. The design pressure for the casing shall not be less than 16 bar for chilled water pumps.

6.04.02 Pump head-capacity characteristics shall be gradually rising from operating to shut off point without any zone of instability. The pump BHP-flow characteristics shall be preferably be non-over loading type beyond rated capacity point.

6.04.03 Operating speed of the pump shall not preferably be more than 1500 rpm. Vibration isolations of efficiency 90% (approx.) shall be provided.

6.04.04 Material of the pump shall preferably as follows (all material shall be of tested quality).

a)	Casing	:	Cast Iron, as per IS 210, Gr FG 260 for both CHW & CW pumps. (As per manufacturer's Standard)
b)	Impeller	:	Bronze to IS: 318 Grade 2
c)	Shaft	:	Carbon Steel C-45.
d)	Shaft sleeve	:	Bronze
e)	Wearing ring	:	Bronze
f)	Base Plate	:	Cast Iron

6.04.05 Pumps shall be provided with suitable bearings sized adequately to take the maximum possible unbalance load occurring due to all mechanical and hydraulic reasons.

6.04.06 Pump and drives shall be directly coupled through a flexible coupling. Suitable coupling guard shall be provided for each pump.

6.04.07 Each pump shall be completed with pressure gauge at the suction and discharge, isolating valves, all integral piping required for sealing and cooling, casing drain and vent connections etc. The pressure gauge of pump will be connected with a siphon and a two-position brass cock.

6.04.08 The rated BHP of the motor shall provide for 15% margin over the rated BHP of the pump. For other electrical particulars of the motor refer detailed specification of the motors.

6.04.09 The design of the pumps shall conform to the relevant IS Code.

6.04.10 Major rotating components of the pumps like impellers, balancing drums etc. shall be individually balanced statically and finally each pump shall be dynamically balanced.

6.04.11 The critical speed of the pump shall be at least 20% above the operating speed.

6.04.12 All pumps and motors shall be aligned properly, and bolted and doweled to a common base frame.

6.05.00 **Induced Draft Cooling Towers**

6.05.01 The cooling towers shall be cross flow induced draft type with FRP casing & sump with air entry on all four sides and air discharge on top. The fan motor shall be easily accessible from outside and out of moist air stream.

The internals shall be of stainless steel SS or MS epoxy painted to withstand corrosive atmosphere. The tower shall be of low height, suitable for round the clock operation at location in the space shown in the applicable drawings. The tenderer shall confirm that the tower supplied by them can be accommodated in the space shown in the drawing.

6.05.02 Cooling tower shall be of sufficient capacity to cool the rated amount of water through the specified range at the design W.B. temperature.

6.05.03 The structural frame work of the tower including all members and connections shall be designed for operating loads and prevailing wind pressure. Steel members shall be MS epoxy painted and be of sufficient size to safely withstand all imposed loads.

6.05.04 FRP casing sheets shall be clamped on close centre to the structural steel members. Rubber neoprene gaskets must be used on all bolted joints as a seal against water leakage.

6.05.05 Louvers shall be of fixed type.

6.05.06 The fan deck shall be of ample strength to support all loads normally encountered in operation and maintenance. Stiffeners shall be provided on the under side.

6.05.07 Galvanised steel ladder with safety cage and hand railing shall be provided in such a number and locations as necessary to give safe and complete access to all parts to tower requiring occasional inspection or adjustment. An access door shall be provided for fan deck and the cell for ready access to the interior parts of the tower.

6.05.08 Fills shall be of extended area of formed PVC suitable to withstand hot water temperature of 55℃.

6.05.09 Louvers and drift eliminators shall be of PVC/FRP construction.

6.05.10 Eliminators shall be provided in removable sections & installed in the cell of the tower. The number of deflection in the eliminators shall be so arranged as to reduce drift loss to 0.2% of the water circulated.

6.05.11 The water distribution system shall be open basin with gravity feed nozzles. The system shall be self draining and non-clogging and designed for flexible operation and ready accessibility. All main piping connection shall be brought out and end in flanges, to flexible connection.

6.05.12 The cold water basin shall be of F.R.P. construction. The basin shall be complete with float valve for male up water control, a drain and overflow connection. The make-up water supply pipe shall be positioned at least double the pipe diameter above the maximum water level in the basin. The water basin shall be constructed such as to provide a coarse strainer of Brass wire mesh easily accessible from outside.

6.05.13 Fan shall be of the propeller type, cast aluminium and multi bladed aerofoil construction with adjustable pitch. The entire fan assembly shall be statically balanced. Outlet velocity of air shall be not less than 610 meters per minutes and the fan tip speed shall not exceed 4570 meters per minute.

6.05.14 Each fan shall be gear driven. Where reduction gears are used, housing shall be of heavy cast iron construction with large oil reservoir and complete with supply of oil.

6.05.15 Fan motors shall be of the totally enclosed fan cooled type and of the required capacities. Motor shall preferably be located outside the moist air stream.

6.05.16 Fan drive shaft using reduction gearing shall be dynamically balanced and connected through flexible couplings.

6.05.17 The mechanical equipment assembly shall be adequately supported on the fan deck.

6.05.18 Fan discharge hatch shall be covered with galvanised wire mesh to prevent birds nesting during idle periods.

6.05.19 All nuts, bolts and fasteners used in the cooling tower shall be stainless steel / Nickel or chrome plated.

6.06.00 **Piping**

A. Refrigerant Piping

I. Refrigerant piping shall be of M.S. seamless (as per IS-1239, Part-I heavy grade) or copper tube (IS-5493). Welding rings shall be used for smaller pipes. Weld preparation of joints, cleaning of pipes shall be carried out as per relevant code.

II. Pressure drop in hot gas, liquid and suction lines should not exceed the value corresponding to 2 °F (1.1 Deg C) change in saturation temperature of the fluid.

III. Velocity in the discharge and suction pipe of the refrigerant shall not be too high as to create undue vibration and noise, velocity in the vertical length of discharge and suction pipe of the refrigerant shall be high enough to carry the entrained oil in the refrigerant, even in case of unit running at lowest partial capacity. An angle type drain valve with male flare outlet connection will be installed at the bottom end of each vertical riser pipe to drain any accumulated oil.

IV. Instrument piping for gauges, switches etc. shall be copper only. Capillary tubes will be used wherever possible. For field-mounted instruments, this is not applicable.

V. Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Bidder.

VI. Liquid-moisture indicator with leak proof glass on opposite sides shall be provided in the liquid line for facilitating visual inspection of liquid refrigerant charge.

VII. The liquid line shall be provided with Drier-Strainer.

B. Water Piping

I. Condenser cooling water piping and chilled water piping for 150 NB or below GI-Heavy Class conforming to IS-1239, Part-I, for higher sizes black steel pipe, heavy grade conforming to IS-3589, Fe 410 grade. Drain water piping shall be of M.S. heavy grade.

II. The piping shall be so designed that the water velocity through the piping shall not exceed 2.5 m/sec and also the piping friction drop shall be limited to 4 m per hundred meters of pipe length. Pipe sizes indicated in tender drawings shall be followed.

III. The pipes shall be of plain end in case of M.S. Pipes (i.e., suitable for welded connections) as far as possible.

IV. Counter-flanges for connecting to flanges on valves or equipment shall be made of IS-2062 or superior and shall preferably be slip on type, suitable for welding on the piping in case of M.S. Piping.

V. All bolts and nuts for flange connection shall be hexagonal carbon steel type as per IS-1363 and with the material and other requirements as per IS-1367. All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flanged connections for ease of removal / replacement of valves.

VI. Bends, fittings fabricated at site are not acceptable. The Contractor shall use the standard fittings / bends, as per IS-1239, Part-II.

VII. Spacing and location of hanger shall conform to preferred engineering practice. Hangers and supports shall be made up of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes, wherever applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the

Bidder. The supports within the plant room shall be of structural/pipe supports from the floor, provided by the A.C. Contractor.

VIII. The flanged joints for water line will use canvas, impregnated rubber gasket. Compressed fiber gaskets shall be used with flat face flanges and raised face slip-on flanges. Spiral wound gaskets shall be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

Gaskets shall be suitable for the design pressures and temperatures: -

i) Compressed Fiber Gaskets: Compressed fiber gaskets shall be in accordance with ANSI B16.21, and materials shall be suitable for a maximum working pressure of 40 bar and a maximum working temperature of 400° C. Gaskets shall be dimensioned to suit the contact facing. They shall be full faced for flat face flanges and shall extend to the inside edge of the boltholes on raised face flanges. Gaskets for plain finished surfaces shall be not less than 1.6 mm thick and for serrated surfaces shall be not less than 2.4 mm thick.

ii) Spiral Wound Gaskets: Spiral wound gaskets shall be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. The gasket shall be inserted into a steel gauge ring whose outside diameter shall fit inside the flange bolts properly positioning the gasket. The gauge ring shall serve to limit the compression of the gasket to the proper value. Compressed gasket thickness shall be 3.3 mm ±0.1 mm.

iii) Ring Joint Gaskets: Ring joint gaskets shall be octagonal in cross section and shall have dimensions conforming to ANSI B16.20. Material shall be suitable for the service conditions encountered and shall be softer than the flange material.

iv) Rubber Gaskets: Rubber gasket materials shall be cloth inserted sheet rubber and shall conform to ANSI B16.21. They shall be full face and 1.6mm thick.

The material should be able to withstand adequate strength in compression without damage. Pipe lines should be such installed that any equipment or valves can be removed by disconnecting flange bolts and nuts union joints. If necessary, a short piece joint to be installed for easy removal. All threads for screwed joints should be properly made. The threads will be covered to make a leak proof joint. Pipes passing through any building structure will pass through a pipe sleeve. The thickness of pipe sleeve will be not less than the

thickness of the passing pipe itself. A rubber grommet or such other material will protect pipes entering any equipment.

IX. All drainpipes will use 'tee' fitting instead of elbows or bends. 'Tee' fitting should be such installed that the plug can be removed and any section of pipe can be cleaned. Drain valves will be located at lowest point of pipelines. If necessary more than one drain valve will be

installed to facilitate complete drainage from pipe. Condensate drain piping shall be insulated as per the specification.

X. Water filling valve and air vent shall be installed on the highest point of pipeline. If necessary more than one valve is to be installed for satisfactory operation or maintenance of the plant. In case of insulated pipes the connections for pressure gauge, thermometer, drain valve, purge valve, filling valve and any such other accessories, the connection should be long enough such that the requisite pipe insulation can be carried out on the main pipe. The connecting pipes or fittings will be insulated separately if necessary. Location of instruments, fittings, fixtures shall be as in single line flow diagram. Location / sizes of air vents are also indicated.

XI. The insulation will be fixed as per manufacturer's recommendation. Where valves, pipe fittings etc. occur, access to both shall be provided. Flange insulation shall be in two halves for easy removal without affecting insulation covering adjacent parts. Insulation of valves shall be with provision of aluminium valve boxes with hinged cover / halves.

XII. Piping arrangement and alignment shall be as per layout.

6.07.00 **Valves & Accessories**

A. General

Valve pressure classes, sizes, types, body materials, and end preparations shall generally be as described herein. Special features and special application valves shall be utilized where required.

Valves specified to have flanged, socket-welded, or screwed connections shall have ends prepared in accordance with the applicable ANSI standards. Steel flanges shall be raised face type unless otherwise required. Cast iron and bronze flanges shall be flat-faced type. Butt-welding ends shall be prepared in accordance with 2.11.5 Butt Weld End Preparation and Piping Fit-Up.

Steel body gate, globe, angle, and check valves shall be designed and constructed in accordance with ANSI B16.34 as applicable. Valve bodies and bonnets shall be designed to support the valve operators (hand wheel, gear, or motor) with the valve in any position, without external support.

B. Steel Body Valves 50 mm and Smaller

Steel body valves 50 mm and smaller shall have forged steel bodies. Forged steel valves complying with the standards and specifications listed in Table 126.1 of ANSI B31.1 shall be used within the manufacturer's specified pressure temperature ratings with the following limitations. The use of Class l500, 2500, and 4500 forged steel valves shall be limited in accordance with the pressure temperature ratings specified in ANSI B16.34, and the criteria established in MSS SP-84.

Class 800, 1500, 2500 and 4500 forged steel valves shall be constructed as follows: -

a) Class 800 valves shall have bolted bonnet joints. Class 1500, 2500 and 4500 valves shall have pressure seal, integral, or breech lock bonnet joints. Gate, globe, and angle valves shall have outside screw and yoke construction.

b) All valves, except gate valves, shall have seats of the integral type. Gate valves shall have renewable seats.

c) Class 1500, 2500, and 4500 valves shall be of loose back seat design.

d) Class 1500, 2500, and 4500 globe valves shall be of the Y-pattern type.

e) Valve ends shall be socket-weld type unless otherwise required.

f) Except as otherwise required, check valves shall be of the guided piston or swing disk type. All check valves shall be designed for installation in either horizontal piping or vertical piping with upward flow.

C. Steel Body Valves 65 mm and Larger

Steel body valves 65 mm and larger shall have cast steel bodies. The face-to-face and end-to-end dimensions shall conform to ANSI B16.10. The use of these valves shall be in accordance with the pressure temperature ratings specified in ANSI B16.34 as applicable.

Gate, globe, and angle valves shall be provided with back seating construction; and shall be of outside screw and yoke construction. Gate valves 100 mm and larger shall have flexible wedge disks. Split disks shall not be permitted. Valves shall have full size ports, except where venturi ports are specifically permitted to Engineer’s approval. The use of valves with venturi ports shall be limited to selected large diameter, high-pressure valve applications.

Class 150, 300, and 400 valves 65 mm and larger shall be constructed as follows: -

i) Bonnet joints shall be of the bolted flanged type having flat face flange facings for Class 150 valves; and male and female facings for Class 300 and 400 valves.

ii) Body ends shall be butt weld type unless otherwise required.

Class 800, 900, 1500, 2500, and 4500 valves 65 mm and larger shall be constructed as follows: -

i) Bonnet joints shall be of the pressure seal or breech-lock type.

ii) All Class 800, 900, 1500, 2500, and 4500 valves shall have grease-lubricated antifriction bearing yoke sleeves.

iii) Body ends shall be butt weld type unless otherwise required.

Check valves used on pump discharge installations, and on other applications in which the valves may be subjected to significant reverse flow water hammer or fluid surges, shall be of the non slam tilting disk type. All other check valves shall be of the guided piston, swing disk, or double disk spring check type. The use of double disk spring check valves shall be limited to 350 mm and larger cold-water services. All check valves shall be designed for installation in either horizontal or vertical piping with upward flow. Stop check valves, where specified, shall be Y-pattern globe type.

D. Iron Body Valves

Iron body gate, globe, and check valves shall have iron bodies with bronze trim. The face-to-face dimensions shall be in accordance with ANSI B16.10. These valves shall have flanged bonnet joints. Gate and globe valves shall be of the outside screw and yoke construction. Body seats shall be of the renewable type. Gate valves shall be of the wedge disk type. Lined cast iron body diaphragm and check valves used with lined piping shall be flanged body with liner and diaphragm material suitable for the service.

E. Butterfly Valves

Rubber-seated butterfly valves shall be generally constructed in accordance with AWWA C504 Standard for Rubber-Seated Butterfly Valves. The valves shall also generally conform to the requirements of MSS Standard Practice SP-67, Butterfly Valves. Valves of the wafer or lug wafer type shall be designed for installation between two ANSI flanges. Valves with flanged ends shall be faced and drilled in accordance with ANSI B16.1. The selected use of butterfly valves shall be in accordance with the pressure temperature ratings specified in AWWA C504, the pressure temperature ratings specified by the manufacturer as per the following criteria: -

a) Butterfly valves shall generally be used for 150 mm and larger cold-water services only.

b) Butterfly valves for buried service shall be of cast iron body material and shall be equipped with flanged ends.

c) Cast iron butterfly valves shall have pressure class selected based on the piping design pressure as follows:

	Piping Design Pressure	**Valve Class**
i)	1.8 bar and below	Class 25

ii)	Above 1.8 bar to 5.2 bar	Class 75
iii)	Above 5.2 bar to 10.3 bar	Class 150

d) Cast iron butterfly valves shall be limited to use with piping systems having a design temperature of 50 C or less.

e) Butterfly valves for other than buried service shall be of carbon steel or cast iron body material depending on the service application. Valves 600 mm and larger in size shall be equipped with flanged ends. Valves 500 mm and smaller in size shall be of the wafer type, or lug wafer type, if used with steel piping; and shall be flanged if used with other piping materials (cast iron, etc.).

f) Carbon steel butterfly valves shall be limited to use with piping systems having a design temperature of 65 C or less. Carbon steel butterfly valves shall have pressure class selected in accordance with the pressure temperature ratings specified in ANSI B16.34 for 600 mm and smaller valves. Valves 750 mm and larger in size shall be selected and specified based on the piping design pressure and temperature, without reference to a specific pressure class.

Metal seated or Teflon seal ring seated butterfly valves for special service applications shall be of the wafer or lug wafer type; and shall be designed for installation between ANSI flanges. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

F. Bronze Body Valves

Bronze gate and globe valves 50 mm and smaller shall have union bonnet joints and screwed ends. Bronze gate and globe valves used in control air service shall have brazed joint ends. Gate valves shall be inside screw, rising stem type with solid wedge disks. Globe valves shall have renewable seats and disks.

Bronze check valves 50 mm and smaller shall be Y-pattern swing disk type or guided piston type designed for satisfactory operation in both horizontal piping and vertical piping with upward flow.

Bronze valves 65 mm and larger shall have bolted flange bonnet joints and flanged ends. Gate and globe valves shall be of the outside screw rising stem construction. Gate valves shall have either integral or renewable seats. Globe valves shall have renewable seats.

The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer and in accordance with the criteria established in MSS SP-80. Bronze valves shall generally be Class 200, and shall be limited to service with piping systems having design pressures of 14 bar or less, and design temperatures of 65°C or less.

Bronze valves shall generally be limited to a size of 80 mm or less.

G. Plug Valves

Plug valves shall be of the eccentric, lubricated, or Teflon sleeve plug type, as required by the service. Plug valve bodies shall conform to the requirements of ANSI for dimensions, material thickness, and material specifications. Bonnets shall be of the bolted flange type. Body ends shall be flanged, faced, and drilled

for installation between ANSI flanges. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

H. Ball Valves

All ball valves shall have full area ports, Teflon seats & seals, and chrome plated carbon steel or stainless steel balls. Ball valve bodies 50 mm and smaller shall have threaded end connections. Ball valves 65 mm and larger shall have flanged ends. The valves shall not require lubrication. The use of these valves shall be in accordance with the pressure temperature ratings specified by the manufacturer.

I. Check Valves

These shall be swing check type with material of construction as given above. The body shall be of cast iron with flanged ends.

J. Flow Regulating-Cum-Measuring Valves

These are special valves to be installed at the outlet of each cooling coil/heating coil as shown in drawings. The Contractor shall also supply measurement it including manometer. The valves shall be of variable orifice design double regulating type. The valve shall have measurement ports for connecting the manometers. The Contractor shall supply all calibration charts etc. The valve shall have provision for locking at pre set flow condition and it shall be possible to close the valve and again open up to this pre set point. The valves shall be of gun-metal/bronze construction.

K. 3-Way Mixing Valves

These are special valves to be installed at the outlet of each AHU heating coil as shown in drawings. The motor shall be actuator based controlled. The valve shall operate from the sense of the room thermostat. The Contractor shall also supply measurement kit including manometer. The valves shall be of variable orifice design double regulating type. The valve shall have measurement ports for connecting the manometers. The Contractor shall supply all calibration charts etc. The valve shall have provision for locking at pre-set flow condition and it shall be possible to close the valve and again open up to this pre set point. The valves shall be of gunmetal / bronze construction.

L. Refrigerant Valves

All refrigerant valves as may be applicable shall have Brass body with flange connection or sweat connection for welding or brazing to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. The valve body and bonnet connection shall have bolted and welded connection.

It is preferable to have Teflon gland packing for the valves construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak proof-ness of the valves shall be tested at

minimum 1.5 times the design pressure for the system but not less than 35 Kg / Sq. Cm.

6.08.00 **Air Handling Equipment**

6.08.01 Air Handling Units

A. FAN

The fans shall be forward/backward curve bladed centrifugal type. The number of fans per unit shall be as per standard of the manufacturer. The impeller and the scroll casing of the fans shall be made of steel and protected with suitable painting as per Manufacturer's standard.

The fan shaft shall be of Carbon steel. Bearing shall be heavy-duty self-aligning type. The fans shall be dynamically balanced. The motor shall be adequately rated to prevent overload.

B. DRIVE

Centrifugal fans shall be equipped with V-belt drive and belt tensioning arrangement. All belts shall be sized with 1.1 service factor. All belt drive shall be equipped with removable guards to avoid accidental hazards. There shall be a minimum of two belts per drive.

C. DRY FILTER

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filters shall be of dry panel type. The filter shall have G.I. frames of adequate thickness but not less than 20 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

D. COOLING COIL

The cooling coil for chilled water shall consist of seamless copper tubes with aluminium fins. There shall be preferably only one cooling coil per AHU or as per manufacturer's standard.

The cooling coil for chilled water plant shall be equipped with manually - operated flow regulating valve with provision for flow balancing at site to control the chilled water flow. This cooling coil shall be designed for chilled water / air duty. Counter-flow process of heat transfer shall be considered in the design requirement. The flow factor of 0.001 Hr. Sq. Ft. - ℉ / BTU (0.0002 hr - Sq. M ℃ / Kcal) shall be taken in the design of the cooling coil. Number of rows shall be minimum 4 and shall follow even number for any

particular coils to facilitate connection of water/refrigerant only on one side of the unit.

Fin design shall be chosen for the duty to be performed with special attention to the possibility of lint accumulation. However, in any case, number of fins in the coils shall not exceed 13 / Inch. Velocity of air across the coils shall be limited to 2.5 m/sec.

In case of chilled water-cooling coil, arrangement for air purging and water draining from the coil is to be provided.

E. CASING

a) The casing shall be of double skin type GI with at least 25mm thick PUF insulation (density approximately 35Kg/ M^3) in between two skins (made of 24 G GI sheet) and complete with supply air outlets with volume control dampers and flexible connections, structural frame work with supports and serrated rubber pads as vibration isolators and shall be provided with thermal break at the joints of different sections. Outer skin of the AHU shall be powder coated.

b) Base frames shall be supplied for floor mounted type units. Drain pans shall be in SS-304 construction having at least 65mm depth and shall be fabricated in such a way to form the slope towards drain point.

c) The main structure of the Unit (i.e. framework) shall be in extruded aluminium construction. The structural members shall have industrial anodized finish to form scratch proof, corrosion resistant, smooth finish surface. The structural member shall have a thermal break between inner & outer surface to minimize heat loss. The sealing surface of the extrusions shall be provided with the groove to hold the gasket. The gasket shall be of synthetic construction having tubular shape for proper sealing. The inner face of the panels shall be flushed with inner face of the extrusions to minimize the corners.

d) Panels of the casing shall be fitted reasonably airtight with suitable gaskets with cams or similar fastenings for easy opening.

e) Necessary arrangement shall be provided on the casing for measuring temperature and pressure in a cooling coil.

f) Easily open able inspection doors shall be provided at required locations for easy maintenance. The Doors shall have handles and hinges in glass filled nylon construction.

g) The Lock shall be flushed type to minimize projections. Locks shall have proper arrangement to secure the doors tightly.

6.08.02 Fan Coil Units

A. The fan coil units shall be of reputed make – horizontal type for ceiling suspension. The units shall be complete with chilled water coil, one or more centrifugal fans and motors, cleanable HDPE filters, double wall insulated condensate drain pan with 15 mm thick expanded polystyrene (self extinguishing quality) insulation sandwiched between top and bottom sheets of drain pan and 18 gauge sheet steel casing panels. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pans.

B. Access panels shall have positive locking fasteners for easy removals. The filters shall be mounted at the rear section of the cabinet with filter box.

C. All cooling coils shall be standard three row staggered seamless copper tube with aluminium plate fins mechanically bonded to copper tubes. Tubes shall be aluminium 10 mm 0.D. and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within the insulated end sections of the base unit for protection against sweating. Each coil shall be provided with an air vent and drain plug. All coils shall be factory tested at 21 kg. Per Sq. cm. air pressure while submerged in water. Fin spacing shall not be less than 10 fins per inch. Tubes shall be mechanical / hydraulically expanded for thermal contact resistance with fans.

D. Fans shall be centrifugal, forward-covered, and direct driven by shaded pole motor.

E. All fans coil units shall be equipped with copper piping connection and manual air vent at the cooling coil. 0ther accessories shall be wall mounted thermostat for individual unit, containing two speed and ON / Off control for fan speed, motorized there-way diverting/mixing valve for individual unit, Y-strainer, ball valve and globe valve, adjustable discharge air grilles.

F. The fan coil unit shall be selected for the lowest operating noise level. It should offer capacity at the lower speed.

6.09.00 **Air Filters**

6.09.01 Pre-Filters

The filter media shall be designed to hold dust and prevent it from being dislodged by vibration or other cause and passing through filter.

The filters shall be of HDPE construction. The filter shall have G.I. frames of adequate thickness but not less than 20 SWG suitable for long use in an industrial plant. The filters may be in panels of sizes about 600 mm x 600 mm for easy handling of the same. The face velocity of air across the filters shall not exceed 2.5m/sec and maximum limitation pressure drop will be 6 mm of WG. Filter thickness will be at least 50 mm. The efficiency shall be about 90% down to 10-micron size particles.

6.09.02 High Efficiency Filters

The filters shall be having efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall not exceed 1.5 m/sec.

High efficiency filters shall be provided with differential pressure switch with alarm.

6.10.00 **Duct Work**

6.10.01 Velocity of air in any section of the supply duct shall not exceed 8 m/sec.

6.10.02 Sheet metal thickness for AC duct shall conform to IS-655.

6.10.03 The general layout of the ducting location and number of air grilles and diffusers etc. shall conform to the specific requirements of individual areas of application so as to ensure proper air distribution of all the zones. The same shall be subject to approval by the Engineer.

6.10.04 Where dimensional locations are not indicated on the drawings, the Contractor will be responsible for the final arrangement and routing of the ductwork. Variations in duct sizes may be made as acceptable to the Owner if the cross-sectional area remains the same and the revised aspect ratio is less than four. Ductwork will be arranged to minimize pressure drop using low-loss fittings and transitions. Where radius elbows are used for duct turns, the radius ratio will not be less than 1.5 wherever possible. Where space limitations require a bend with a radius ratio of 0.75 or less, not less than two turning vanes will be installed in the bend.

6.10.05 All ductwork for supply of air inclusive of accessories such as damper, vanes, access doors etc. shall be fabricated from G.I. sheet of at least grade 180 as per IS 277 or aluminium sheet. 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.

6.10.06 The construction of ducts shall conform to IS : 655/ASHRAE/SMACNA as far as applicable, unless otherwise stated here.

6.10.07 JOINTS

a) All longitudinal joints for the ducts will be Pittsburgh Lock seam type.

b) Transverse joints for the low-pressure ducting shall be continuous around the four sides, the corner closure are required. The type of transverse joints shall be as follows:

Large side mm	Type of transverse joints
Up to 600	25 mm wide pocket, drive or S-slip
601 - 1000	85 mm wide, bar s-slip or pocket slip
1001 – 2250	40 mm x 40 mm x 6 mm M.S. angle connection

c) The low-pressure ducting work shall be provided with intermediate transverse bracing continuous around the four sides between the joints according to the following sizes:

Large side mm	Bracing
0 - 450	None
451 - 1500	40 mm x 40 mm x 6 mm angle 1200 from joints.
1501 and above	40 mm x 40 mm 6 mm angle 600 mm from joints.

d) Riveting and Sealing

All joints, slips and seams shall be made secure by reverting on centres not exceeding 150 mm. All transverse stiffeners and all reinforced bar slip joints shall cross at corners and be riveted. All bar slip joints and angle iron bracing shall be riveted on centres not exceeding 75 mm.

e) All construction joints and duct seams shall be reasonably sealed with bitumastic cold emulsion or equivalent vapour seal.

6.10.08 Hangers and Supports

a) All ductwork shall be provided with adequate hangers or supports to ensure rigid support and to prevent vibration. Spacing of duct supports shall not exceed 3 m centres.

b) Hangers shall be suspended from the building steel with provision for necessary auxiliaries, or special steel members, or by hooks fixed to the embedded plates provided in the ceiling.

c) Hangers for all ducts shall be trapeze type with the shelf construction from 35 mm x 35 mm x 5 mm angle iron and hung by two steel rods each of not less than 10 mm dia. for ducts, with larger side less than

2250 mm while for those greater than 2250 mm shall be with 50 x 50 x 5 angles and rods not less than 16 mm dia.

d) All hangers and supports shall be as per drawings / specifications. When vertical ducts pass through floor slab, they shall be supported by means of collars, constructed of steel structural angles securely fastened about the girth of the duct and bitumastic compound between the horizontal leg of the supporting angle and the floor. The duct aspect ratio shall not be more than 4: 1. Turning vanes are required to be provided with bend more than 45 Deg.

6.10.09 Access Doors

All main ductwork shall be accessible throughout using tight fitted hinged access doors. Doors shall have to be cemented on sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.

Access doors/panels are to be provided at following places:

Near each fire damper
Near each heater coil
Near each filter bank

In case access doors are to be installed in the insulated ducts, the access door panel should be suitably insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the duct when the plant is running.

6.10.10 Flexible Connection

Rubber impregnated canvas or equal flexible connections of at least 150 mm length shall be provided at each connection between ductwork and fan units.

6.10.11 Dampers

i) SPLITTER DAMPER

Splitter dampers in branch take off shall be provided. Dampers blades shall be minimum 16 SWG thick. Alternatively catcher shall be provided in right angle tee of ducts.

ii) FIRE DAMPER

Fire dampers shall be provided as per the requirement mentioned elsewhere in the specification. The fire dampers shall be of motorised / solenoid/fusible link type operated by smoke detectors of the zone fire fighting system. The fire damper shall be smoke-tight type and shall have 120 min. fire rating. Provision shall be kept for manual operation of the damper.

Blade thickness	:	At least 16G CRCA
Frame	:	At least 40 x 40 x 3 mm Angle.

Motorised Fire Dampers shall be rated for 240 V, 50 Hz, 1 Ph., AC supply. Motor for Fire dampers shall be continuously rated. These Dampers shall close on de-energisation and open on energisation of Motor. Provision shall be kept for manual operation of the Damper.

Fire dampers will be provided at the supply/exhaust duct for fire-rated walls/floors as required by National Fire Protection Association (NFPA) and International Building Code (IBC).

iii) ACTUATORS

The actuators will be UL listed.

Dampers will be equipped with operators of sufficient power to control dampers, without flutter or hunting, through the entire operating range at air velocities at least 20 percent greater than maximum design velocity. Operators will have sufficient power on closure to provide tight sealing against maximum system pressures. Damper actuators will be designed to provide a minimum of 200 percent of the torque required to operate the damper and to meet the air leakage criteria. Damper actuators will not be less than 2.26 N-m (20 inch-pounds). Each damper section will contain one or more damper actuators. Jack-shafting of the section is not permitted.

Operators functioning in sequence with other operators will have adjustable operating ranges and set points.

Spring-return operators will be provided for two-position control or on reversible operators where required for fail-safe operation.

Electric motor operators for modulating control will be reversible type.

Locations where temperatures fall below minimum operating temperature of operator will be heated.

When dampers are installed on ducts to be externally thermally insulated, each damper operator will be equipped with stand-off mounting brackets, bases, or adapters to provide clearance between the duct and operator not less than the thickness of insulation. Standoff mounting items will be integral with the operator or standard accessory of damper manufacturer.

iv) OPPOSED MULTIPLE LOUVRE DAMPER

Opposed multiple louvers dampers shall be provided at the fan outlets and wherever mentioned in the drawings, specification and fan schedule. Each blade of the dampers shall be provided with bronze, gunmetal or nylon bearing at each end of its spindle. The spindle with bearing shall be mounted in a strong structural framework. Operating lever with fixing device for keeping the damper at the desired position shall be fitted for the manually operated dampers.

Operating level will be fixed on an indicator to show the percentage of opening of the damper in all cases except for the application with grilles and nozzles.

Velocity across the dampers shall not exceed 10 m/sec. Damper blades at fan outlet shall be made up of 16 gauge M.S.

6.10.12 Diffusers, Grilles, Registers - Conventional Design

Design of grilles & diffusers shall be such as to create desired throw and spread of air and shall be approved by the purchaser/engineer.

All diffusers and grilles shall be made up of powder coated sheet steel / extruded aluminium with finish painting. Design of all diffusers and grilles shall be made by the Contractor matching with the lighting and other fittings and to be approved by the Engineer. Each supply air diffusers shall be fitted with opposed blade damper, built-in vanes and louvers arranged as per manufacturer's standard design.

Side throw type supply registers shall have two sets of adjustable louvers with opposed blade dampers. The front of louvers shall be horizontal to provide horizontal deflection and the rear set of vertical louvers shall adjust vertical deflection. The dampers shall have horizontal opposed blades regulated by an operating lever in the frame. All wall type exhaust / return air grilles shall have one set of louvers in the front. The louvers shall be fitted such as to remain in position by friction grip. All supply air grilles shall have one set of opposed multiple louver dampers at the inlet. The dampers shall be gang operated and will have a device to keep the dampers fixed in one position.

The grille frame and louvers shall be manufactured of at least 20 SWG GI sheet and 22 SWG M.S. respectively. No grilles should by any chance make any rattling sound during continuous operation. All grilles shall match the decor of the space.

All grilles/diffusers shall be fitted with suitable gasket to prevent air leakage.

6.11.00 **Insulation**

6.11.01 Thermal Insulation

A. The following items are to be insulated:

I. Refrigerant suction piping from the evaporator coil outlet up to the compressor inlet shall be insulated with minimum 39 mm thick aluminium foil faced Nitrile rubber/ XLPE for Screw type Package Water Chilling Unit and 26 mm Nitrile Rubber/XLPE with 30G Aluminium sheet Cladding for Precision/ Split Air Conditioner. For better efficiency of operation the liquid line running side by side with the suction line may be insulated together with the suction line already mentioned.

II. Double skin Casing of the cabinet type air-handling unit with at least 25 mm thick Poly Urethane Foam (PUF)/ EPS sandwiched between them.

III. Supply air duct and part of the return air duct passing through non conditioned space, if any, with at least 13mm thick aluminium foil faced Nitrile Rubber / XLPE Insulation.

IV. Entire chilled water-piping, valves, chilled water circulating pumps, and chillers with 39 mm thick aluminium foil faced Nitrile rubber/XLPE.

The portion of Chilled water piping exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene and finished with chicken wire mesh, 12 mm thick sand-cement plaster and an overall cladding of 30G Al. sheet.

V. Drain Piping from AHU/Precision ACs /Split AC unit/ FCU and Chillers shall be insulated with 13 mm/ 6mm (for FCU and Split units) thick aluminium foil faced Nitrile Rubber/ XLPE.

VI. Screw type Packaged Chiller and Chilled Water Pump shall be insulated with 39 mm thick aluminium foil faced Nitrile Rubber/ XLPE.

VII. Chilled water Expansion tank drain piping with 6 mm thick aluminium foil faced Nitrile Rubber/XLPE.

VIII. Insulation of Precision AC Unit/ Split AC Unit shall be as per manufacture's standard.

IX. Roof of AC spaces shall be insulated with 25 mm thick EPS (under deck) for not exposed to sun and 50mm thick EPS (under deck) for exposed to sun.

B. Insulation shall be fixed as per manufacturer's recommendation. Due care shall be taken to avoid damage to vapour arresters and insulation.

C. Extra insulation thickness shall be provided at duct pipe hangers and special care shall be taken to seal the insulation and hanger member penetrations and instruments and accessories tapings.

D. Special care shall be taken to provide satisfactory insulation for valves, flanges, vessel connections etc. with proper facility for maintenance and inspection.

E. Insulated ducts crossing the floors shall have to be normally protected from damage and water splashing by providing suitable cladding up to 300 mm from the floor level.

6.11.02 Acoustic Insulation

All supply air ducts in the air conditioning system shall be insulated with Acoustic insulation of 25 mm thick open cell erosion resistant Nitrile Rubber foam of density min. 140 Kg/CuM provided in the ducting up to a length of 6 M from the Air Handling Unit / Precision Air Conditioner.

6.12.00 **Precision / Split AC Units**

6.12.01 Water Cooled Precision Air Conditioners

A. Compressor

The compressor shall be hermetically sealed scroll type medium speed, single acting type designed for R-407C/410A duty. The compressor shall be complete with crank case heater (to be energised when compressor is on off cycle).

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

B. Condenser

All condensers shall be of shell and tube type with water in the tubes and refrigerant in the shell.

The heat exchanger shall be designed for a minimum working pressure of 10.5 kg/cm^2 gauge on the water side and 19.0 / 27.0 kg/cm^2 for R-407C / 410A on the refrigerant side and shall generally conform to the latest ASME CODE for unfired pressure vessels Section- VIII. The design pressure shall have a reasonable margin over the maximum working pressure.

The average velocity of water in tubes shall not be more than 2.5 m/sec.

Water heads or refrigerant heads of the heat exchangers shall be as not to allow leakage of fluid from one pass to the other.

Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating.

The overall fouling factor for the condensers shall be 0.0002 $Hr.M^{2o}C/K.Cal$.

The condensers shall be designed to provide at least 2 ℃ sub cooling of refrigerant under rated design condition.

Testing and other design feature of the heat exchanger shall meet the requirements of TEMA Class-C heat exchangers or approved equal.

The heat exchangers shall have open able water boxes for ease in maintenance.

The tubes for the condensers shall also be copper with integral fins. The tube wall thickness at any point shall not be less than 18 SWG.

The baffle plates and the tube sheets shall be made of steel. The shell shall be made up of seamless tube or shall be fabricated from flange quality steel plate (ASTM-A285 Grade-C). The tube support plates shall be made of flange quality carbon steel plates and shall be as per TEMA Standard.

The heat exchangers shall be provided with vent valve, relief valve, and/or safety fusible plug on refrigerant side and vent valve and drain valve on water side (at every section of the baffled shell of heat exchanger).

The tenderer shall quote packaged units having compressor, condenser and evaporator assembly together in a single framework and mounted on a common base plate. Provision for refrigerant charging and chemical cleaning of water tubes shall be provided.

Each heat exchanger shall be provided with water flow switch. This shall be interlocked with the control of the individual refrigeration system/ corresponding compressor drive.

All the heat exchangers shall be provided, with standard connections like thermo wells, inspection valve and antifreeze thermostat and external equaliser connection for expansion valves. Insulation shall be terminated in such a manner that it will not be damaged during removal of bolts, covers etc. Separate covers similar to flange covers shall be constructed to facilitate easy removal.

The design pressure shall have a reasonable margin over the maximum working pressure.

C. Evaporator Cooling Coil

The cooling coil shall be direct expansion type with multi-row deoxidised copper tubes with aluminium fins. Air velocity across the coil shall be limited

to 2.5 m/sec. The coils shall be pressure tested and thoroughly dehydrated before assembling.

The coil shall be placed to make the system draw through type. Refrigerant feed control shall be by electronic expansion valve. Temperature control shall be through microprocessor based control panel. Insulated condensate drain pan of SS construction shall be provided within the unit.

The unit shall be factory assembled, wired, with inter connecting refrigerant piping and built-in microprocessor based control console and tested as per the relevant code.

The cooling coil shall be to produce the capacity required under specified coil condition and air quantity. Heat load calculation to check the system selection shall be carried out and submitted by the tenderer.

D. Evaporator Fan

The fan shall be heavy duty DIDW centrifugal type statically and dynamically balanced with forward/backward curve blade, directly driven by high efficiency EC motors. Fan wheels and casing shall be constructed of steel and mounted on steel shaft. The bearings shall be ball bearing type mounted on vibration absorbing rubber mounts. The fan motor shall be mounted within the cabinet. Motor horsepower shall be sized for 120% of the rated power required.

The supply fan shall be sized to deliver the required air quantity against the total external static pressure required for the system application, after taking care of all internal static pressure requirements of the units.

E. High Efficiency Filter

A set of High efficiency filters will be located inside the PAC unit cabinet. The filters shall be high efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling them.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall preferably not exceed 1.5 m/sec.

F. Humidifier

The humidifier shall be of Electrode type and shall be placed inside the PAC unit cabinet. The humidifier shall be electronically controlled through the built-in microprocessor based control panel of the unit. A provision of make-up water connection with the humidifier shall be kept with the Unit cabinet.

G. Electric Strip Heater

The PAC unit will be provided wit built-in electric strip heater electronically controlled through the built-in microprocessor based control panel of the unit.

Such control includes both operating and safety controls with the sense of air temperature at the RA path and at the downstream side of the heater respectively.

H. Casing and Cabinet

All components shall be housed in a welded sheet metal cabinet of double skin of not less than 22 G thick MS powder coated sheets. The gap between two skins is filled up with at least 25mmthick PUF/ EPS insulation. Different sections will be constructed with framework and connected with each other in an airtight manner through gaskets, thermal barriers and sealant.

Removable panels shall be constructed of framed 1.6 mm sheet steel with angle iron framing. Units shall be provided with 316 L.S.S. fasteners for easy removal and access for servicing. Air handling section of evaporator shall be provided with an acoustic lining of 25 mm thick fiberglass covered with fiber glass cloth and perforated aluminium sheet on the inside surface of the unit casing.

The return air opening shall be on the front face with a matching grille of same colour finish.

6.12.02 Air Cooled Precision Air Conditioners

A Compressor

The compressor shall be hermetically sealed scroll type medium speed, single acting type designed for R-407C/410A duty. The compressor shall be complete with crank case heater (to be energised when compressor is on off cycle).

The compressor shall have proper lubrication system. Safety devices viz. high-pressure switch, low-pressure switch, low oil pressure (if applicable) shall be provided and such devices shall be electronically operated. Manual reset on safety cut out shall be provided. The horsepower for the compressor motor shall be adequately sized or 110% of the rated power required for the unit including drive loss.

Capacity control shall be devised by providing at least two compressors.

B Condenser (Outdoor Unit)

The Condenser shall be of Air Cooled type and shall be constructed of copper tube with aluminum fins. Tubes shall be designed for a minimum working pressure of 30 kg/ sq. cm. The condenser shall be complete with

fans with drive motors and shall be provided with charging connection, safety relief valve and standard accessories, all encased in a powder coated GI casing with built-in electrical items and supporting frame. The condenser shall have the matching capacity with the compressor. There shall be a provision of isolating switch for the fans.

C Evaporator Cooling Coil

The cooling coil shall be direct expansion type with multi-row deoxidised copper tubes with aluminium fins. Air velocity across the coil shall be limited

to 2.5 m/sec. The coils shall be pressure tested and thoroughly dehydrated before assembling.

The coil shall be placed to make the system draw through type. Refrigerant feed control shall be by electronic expansion valve. Temperature control shall be through microprocessor based control panel. Insulated condensate drain pan of SS construction shall be provided within the unit.

The unit shall be factory assembled, wired, with inter connecting refrigerant piping and built-in microprocessor based control console and tested as per the relevant code.

The cooling coil shall be to produce the capacity required under specified coil condition and air quantity. Heat load calculation to check the system selection shall be carried out and submitted by the tenderer.

D. Evaporator Fan

The fan shall be heavy duty DIDW centrifugal type statically and dynamically balanced with forward/backward curve blade, directly driven by high efficiency EC motors. Fan wheels and casing shall be constructed of steel and mounted on steel shaft. The bearings shall be ball bearing type mounted on vibration absorbing rubber mounts. The fan motor shall be mounted within the cabinet. Motor horsepower shall be sized for 120% of the rated power required.

The supply fan shall be sized to deliver the required air quantity against the total external static pressure required for the system application, after taking care of all internal static pressure requirements of the units.

E. High Efficiency Filter

A set of High efficiency filters will be located inside the PAC unit cabinet. The filters shall be high efficiency of 99% down to 5 microns. The filters shall be of cleanable type construction of reinforced glass fiber or cotton fabric or fabric-like material sand witched in between two galvanized wire netting arrangement in a uniformly corrugated form to increase the surface area.

The filters shall have G.I. frames of adequate thickness suitable for long use in an industrial plant. The filters may be in panels of size about 600 x 600 for easy handling them.

The filter panels shall be mounted on the ladder type angle iron holding frames. The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters. Face velocity of air across the filters shall preferably not exceed 1.5 m/sec.

F. Humidifier

The humidifier shall be of Electrode type and shall be placed inside the PAC unit cabinet. The humidifier shall be electronically controlled through the built-in

microprocessor based control panel of the unit. A provision of make-up water connection with the humidifier shall be kept with the Unit cabinet.

G. Electric Strip Heater

The PAC unit will be provided wit built-in electric strip heater electronically controlled through the built-in microprocessor based control panel of the unit.

Such control includes both operating and safety controls with the sense of air temperature at the RA path and at the downstream side of the heater respectively.

H. Casing and Cabinet

All components shall be housed in a welded sheet metal cabinet of double skin of not less than 22 G thick MS powder coated sheets. The gap between two skins is filled up with at least 25mmthick PUF/ EPS insulation. Different sections will be constructed with framework and connected with each other in an airtight manner through gaskets, thermal barriers and sealant.

Removable panels shall be constructed of framed 1.6 mm sheet steel with angle iron framing. Units shall be provided with 316 L.S.S. fasteners for easy removal and access for servicing. Air handling section of evaporator shall be provided with an acoustic lining of 25 mm thick fiberglass covered with fiber glass cloth and perforated aluminium sheet on the inside surface of the unit casing.

The return air opening shall be on the front face with a matching grille of same colour finish.

6.12.03 Non-Duct able Split Type Air Conditioning Units

A. General

I. The split type room air conditioner consists of two units one Indoor unit (Evaporator) & an Outdoor unit (Condenser). It will be complete with all components to perform filtering and cooling of air in all seasons except winter. The refrigerant condenser will be air-cooled. The unit will be suitable for wall mounting.

II. The unit shall have normal rating capacity as per the schedule mentioned elsewhere in the specification measured at a room temperature 24 ℃ DB and RH not exceeding 65% under design outside conditions specified elsewhere. The capacity variation should not be more than 5%.

B. Indoor Unit

I. The indoor unit consists of panel type dry filter, cooling coil, evaporator fan etc.

II. The filter is panel type dry having an efficiency of 90% down to 10-micron size Particles. The filter media shall be designed to hold dust, sand and prevent if from being dislodged by vibration or other cause and passing through filter. The face velocity of air across the filters shall not exceed 2.5 m / sec.

III. Cooling coil will be direct expansion type made of seamless copper tubes with aluminum fins, number of fins as per manufacturer's standard but not more than 13 per inch & R22. The coils should be located at the suction side of the Evaporator Fans. Velocity of air across the coils shall be limited to 2.5 m/sec.

IV. Piping accessories like Hot gas piping, cold gas piping and liquid refrigerant pipeline all made of copper complete with at least 26 mm thick Aluminium foil faced Nitrile rubber / XLPE or equivalent insulation interconnecting indoor and outdoor units, liquid line valves, liquid refrigerant piping, gauges and instruments, filter-drier, moisture indicator, isolating valves etc., shall be provided as may be required for safe and trouble free operation.

V. The evaporator fan shall be Centrifugal, DIDW with forward Curved blades directly driven by TEFC squirrel cage induction motor operating in AC 240 V ± 10%, 1 Ph, 50 Hz ± 5% supply, with 3- step speed control. The evaporator fan shall be both statically and dynamically balanced.

VI. Sheet metal casing with inspection facilities, made of Powder coated M.S. sheet and complete with suitable refrigerant pipe connections, insulated drain pan, insulated drain piping, supply and return air opening with decorative grilles with automatically swiveling louvers (for supply air grilles). The casing should be insulated inside to prevent condensation. This shall be provided from inside surface to limit the noise.

C. Outdoor Unit

I. The outdoor unit shall consist of a compressor, air cooled condenser with liberally sized aluminium finned copper tube coil and low noise directly driven fan and totally enclosed weather proof motor housed in power coated MS casing.

II. The Compressor shall be rotary type with R-22 refrigerant of specified capacity & motor. The compressor assembly shall be adequately designed for minimum vibration and noise disturbances. The compressor rotor assembly shall be dynamically balanced. The shaft seal shall be of proven design. The horsepower for the compressor motor shall be sized for 115% of rated power required for the unit including the drive loss.

III. Accessories like Suction and discharge valves, safety valve, HP and LP cut out switches, powder coated sheet metal casing, vibration-isolating device, foundation bolts, built in Electricals like starters, switch fuse units, relays, contactors. The speed of the compressor should not exceed 1500 rpm.

IV. Air-cooled condenser with directly driven axial flow fan & adequately sized drive motors (TEFC squirrel cage Induction type) with relief valve, hot gas connection, charging connection with valve, louver at the intake & exhaust of air, and other standard accessories. The condenser fan shall be both statically and dynamically balanced.

V. The heat exchangers shall be designed for a minimum design test pressure of 20.33 Kg/m^2 on the refrigerant pipe. The design pressure shall have a reasonable margin over the maximum working pressure. Tube supports of adequate strength shall be provided to prevent the tubes from sagging and vibrating. The condensers shall be designed to provide at least 4^oC sub cooling of refrigerant under rated design condition. The unit should be operating free from any vibration and noise.

VI. The piping will be thermally insulated wherever required such that there is no condensation on the outside of the piping. The insulation will be of Aluminium foil faced XLPE or Nitrile rubber or equivalent.

VII. Refrigerant piping shall be either of M.S. seamless (as per IS-1239, Part-I heavy grade) or copper tube (IS-5493) or ASA-9-31.5). Pressure drop in hot gas, liquid and suction lines should not exceed the value corresponding to 2 ^oF change in saturation temperature of the refrigerant. Velocity in the discharge and suction pipe of the refrigerant shall not be so high as to create undue vibration and noise, velocity in the vertical length of discharge and suction pipe of the refrigerant shall be high enough to carry the entrained oil in the refrigerant, even in case of unit running at lowest partial capacity. Instrument piping for gauges, switches etc. shall be of copper only.

VIII. All the above equipment along with the electrical items like starter, contactor and other controls shall be encased in a powder coated MS casing. The casing shall be complete with supports fabricated out of MS angles, & sheets (duly painted), anchor bolts, nuts etc. The entire unit shall be installed with rubber pad type vibration isolators.

IX. All refrigerant valves as may be applicable shall have steel or brass body with flange connection or socket connection for welding or brazing to pipe. For copper pipes size 5/8" and below flare connection will be acceptable. It is preferable to have the stems of rising stems inside screw type. The valve body and bonnet connection shall have bolted or welded connection.

X. It is preferable to have Teflon gland packing for the valves. The construction of the discs of the valves shall be either globe or angle type. The valve seat shall have white metal lining or any equivalent soft replaceable lining. The valves shall be of tested quality. Leak tightness of the valves shall be tested at minimum 1.5 times the design pressure for the system.

6.13.00 **Fresh Air System**

6.13.01 For critical areas like control room, control equipment room etc., outside fresh air will be inducted into the AHU room/ PAC room through a Fresh Air system consisting of an inlet louver, dry panel type filter, a fan with a short duct (if necessary), SA register and mixed with the return air in AHU room/ PAC room.

For other non-critical areas like service building fresh air will be inducted in the AHU room through the wall mounted rain protection cowl with bird screen and a volume control damper.

6.14.00 **Miscellaneous Items**

6.14.01 Heater

A. Strip heater

I. Heating equipment wherever required shall be electrical type. All frame members, control box cover and associated sheet metal parts are to be heavy gauge steel with corrosion resistance treatment. Heating equipment may be required for winter heating as well as for reheating. Reheating heaters may be used for winter heating also.

II. Electric heaters will be fin-tube type of specified KW rating, with fins permanently brazed to metal sheath. The metal sheath and fins will be of G.I. sheet material.

III. Wherever electric heaters are installed in the ductwork, size of ducts should be suitably increased to offset the additional resistance created by the heaters. All heaters shall be mounted on such insulators that there shall be no leakage current under all weather condition including high humidity operation. The mounting frame shall be suitably grounded by earth wires / earth leads of two points.

IV. An air stat is to be installed such that in case there is no circulation of air over the heater coils the heaters will be de-energised. Wherever the heaters are installed in the ductwork the terminal block will be such positioned in a junction box that it will be outside the ductwork in an accessible position. The junction box will be vermin proof, rat proof and provided with a hinged cover. A caution plate as per I.E. rules will also be provided. Access door will be provided in the duct near the heating coil for easy inspection and removal / replacement / fixing of individual strip heaters. The capacity of heaters will be distributed over three phases.

V. In case of reheating the heater will be controlled by humidity sensor & humidity transmitter and in case of winter heaters it will be controlled by temperature sensor & temperature transmitter.

B. Electric Room Heater

Electric Room Heaters shall be with High / Low control.

Electric Room Heaters shall be suitable for AC 240 V ± 10%, 1 Ph, 50 Hz ± 5% supply.

6.14.02 Electrode Humidifier

A. Electrode humidifier consists of high temperature Polypropylene water tank, electrodes, auto flash cycle activated on demand from the microprocessor based control system with humidity sensor, located in the AHU / PAC room. Such Humidifier shall be controlled by its own stand-alone microprocessor based control panel. Alarm indication will be provided for low water level in the water tank.

B. Whenever the relative humidity of the conditioned space reaches the minimum allowable percentage of humidity, the humidifier shall be energized to restore the relative humidity. The humidifier shall be such controlled that it shall not exceed the maximum allowable limit of relative humidity in the conditioned space. The humidifier shall be sized and designed accordingly.

6.14.03 Non Chemical Water Treatment Equipment

A. The water treatment equipment is a 1 M long pipeline, which once installed, stops the formation of scale in the heat exchange zones completely.

B. The water treatment equipment consists of Metal Cell and Core and is installed on line after the pumps and before the heat exchange zone. The distance of the heat exchange zone should not be more than 30 M and there should not be any static area between the water treatment equipment and heat exchange area.

6.15.00 **False Ceiling**

6.15.01 Scope

The work under this Section shall include the supply and installation of suspended ceiling using GYPSUM boards together with the suspension system as shown on drawing or specified in Schedule with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or instructed by the Engineer.

6.15.02. Installation

A. Suspension System

General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

Metal Grid Suspension System

Aluminium grid ceiling system shall be "Beadlock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be jolly snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by MS flats, angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces & end tees shall rest on the moulding, unless otherwise shown on drawings.

B. CEILING PANELS

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V-joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and

schedule of items, 6 mm thick cement: lime: sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

6.15.03 Acceptance Criteria

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.15.04 Rates

Shall be lump sum rates for complete items called for in the "Schedule of Items". No extra payment will be made for arrangement for lighting fixtures, air conditioning diffusers, access panels, etc. The rate shall include all cutting and wastage from standard size sheets, boards, runners, etc.

6.16.00 **Electrical Items**

6.16.01 General Electrical Specification

For detailed General Electrical Specification, relevant Electrical section, as applicable, shall be followed.

6.16.02 Drive Motor

For detailed technical specification of motors, relevant Electrical section, as applicable, shall be followed.

6.16.03 Local Push Button Station (LPBS)

For detailed technical specification of Local Push Button Station (LPBS) system relevant Electrical section, as applicable, shall be followed.

6.16.04 Power Distribution Board

For detailed technical specification of Power Distribution Board relevant Electrical section, as applicable, shall be followed.

6.16.05 Cables

For detailed technical specification of Cables relevant Electrical section, as applicable, shall be followed.

6.16.06 Cable Trays and Racks

For detailed technical specification of Cable Trays relevant Electrical section, as applicable, shall be followed.

6.16.07 Grounding

For detailed technical specification of Grounding relevant Electrical section, as applicable, shall be followed.

6.16.08 DDC System

For detailed technical specification of DDC System relevant part of the specification shall be referred to.

6.17.00 **Controls & Instrumentation**

6.17.01 Control System

A. All control shall be electrical / electronic type depending upon the requirement & as specified under the specification.

B. Chilled Water System Controls

All safety controls against high refrigerant pressure, low refrigerant pressure, low oil pressure, high and low voltage, compressor over-load and protection against freezing of the water chiller, low flow condenser cooling water & chilled water shall be provided.

All safety controls against antifreeze protection, pump cavitations, motor protection etc. shall be provided.

Operating thermostat/ temperature sensor sensing outlet water temperature of chiller shall be provided for each compressor. This thermostat/ temperature sensor shall control the liquid line solenoid valve in conjunction with the capacity controller for Screw type. Automatically operated heaters with safety thermostats & automatic unloaded starting device shall be provided for the compressor. Antifreeze thermostat to trip off respective compressor shall be provided for each compressor.

C. Direct Expansion System Controls

All devices for automatic refrigerant flow control by thermostatic expansion valve sensed by the superheat in suction line, solenoid valves in the liquid line to operate in conjunction with automatic capacity control of compressor by room thermostat (as applicable) sensing from the inside temperature of the

conditioned space is to be provided. High pressure and low-pressure cut out, low oil pressure cut out (if applicable), high and low voltage protection, compressor motor overload protection shall be provided. Automatically operated crank case heater with safety thermostats shall be provided for reciprocating compressors.

D. Air Handling Unit Controls

The temperature of all conditioned spaces shall be maintained / controlled by a modulating type 3 way mixing valve. The modulating motor will be operated by getting sense from the temperature sensor and associated transmitter placed in the return air path. There shall also be control valves in the chilled water line (for chilled water units) for manual control of chilled water flow into the cooling coil. These control valves shall be flow regulating cum measuring type with precision adjustment arrangement.

E. Annunciations

Audio-visual alarm facility is envisaged of the system. Details of the annunciation system shall be as per mentioned elsewhere and as per requirement.

6.17.02 **Miscellaneous Instruments**

A. The pressure indicators and temperature indicators shall have minimum 150 mm size dial. The pressure gauges shall be Bourdon type and complete with isolating/valves. The pressure gauge shall conform to IS: 3624 and temperature gauge as per BS: 1041.

B. Water flow switch shall be vane actuator type or differential pressure type, with adjustable actuation set point. The level switch shall be ball float operated magnetic type complete with cage. The switch case shall be weather proof conforming to NEMA-4.

C. Apart from the thermostat, pressure switches, level switches and level indicators specified in this tender document, the local instruments shall also be furnished as a part of the system as shown in drawings enclosed and as per functional requirement.

D. The range of controls and instruments should be such that the operating ranges are preferably in the mid scale. The accuracy should not be less than + 1% of full scale deflection. The repeatability of readings shall be + 1%. The differential in controls should be such that the equipment is able to operate at desired settings or maintain desired condition.

E. The scale of pressure indicators for refrigerants units will be in kg/cm2. Saturation temperature of the refrigerant in use, at the corresponding

pressure should also be indicated in the scale. The suction and oil gauge shall be compound gauge. The scale of pressure indicator for pumps will be in meter. The temperature indicator's scale will be in ℃. The range should be such that even when the equipment is idle and the temperature of the medium is at such variance, the indicator will not be damaged.

F. All instruments should be such selected and installed that they are easily readable from the floor.

7.00.00 SPECIAL TOOLS

The supplier shall furnish a complete set of all special tools, wrenches etc. with necessary toolboxes as required for erection, operation & maintenance, overhaul or complete replacement of any equipment supplied under this specification. The supplier shall enclose a list of such tools recommended by them.

8.00.00 SPARE PARTS

8.01.00 The supplier shall furnish and quote the Mandatory spare parts for the complete Air Conditioning System Equipment as per the list attached in the other part of the specification.

9.00.00 TESTING AND INSPECITON AT MANUFACTURER'S WORKS

9.01.00 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of the applicable codes.

9.02.00 Following tests shall be carried out during and after completion of different component parts as applicable and in accordance with the requirements of the applicable codes.

9.03.00 Material analysis and testing shall be carried out.

9.04.00 Hydraulic test for pressure parts including piping of VAM & its components, pumps, compressors & its components, vessels etc.

9.05.00 Dynamic balancing of all the rotating parts is to be done.

9.06.00 Performance test of Vapor Absorption Chiller, pump, compressors, condenser, cooling towers and air handling units shall be done as per code procedure.

9.07.00 Tests on motors as per Indian Standard IS-325 and IS-4029.

9.08.00 Other tests, as necessary and recommended by the manufacturer.

Test certificates and reports shall be made available to the Purchaser / Engineer on the above tests, for approval and before despatch of equipment.

The representatives of Purchaser / Engineer shall be given full access to all tests. The Tenderer shall inform the Purchaser within 21 days prior to important shop tests so that if the Purchaser / Engineer so desires, their representatives can witness the tests.

Cost of conducting all shop tests shall be borne by the supplier.

10.00.00 **FIELD TEST**

10.01.00 Overall performance of the air conditioning system with peak summer and monsoon outside conditions as well as individual equipment shall be tested after complete installation at site. Duration of such test shall be 72 hours. This test shall be carried out to determine whether the plant meets the performance requirements specified here in and shall include measurements of all parameters under various outside conditions and establishment of correct supply of equipment. All testing and calibrating instruments required for this purpose shall be supplied by the contractor.

10.02.00 Inspection and testing of duct work

All component and duct work supplied shall be subjected to inspection and testing as per relevant codes and standard.

10.03.00 All ductwork shall be carefully examined to determine their performance with the specification with respect of dimensions, materials, marking, leakage, workmanship and other requirement.

10.04.00 The contractor shall give assistance for all site tests of the equipment according to prescribed procedure laid down by the Manufacturer / Engineer.

11.00.00 **PERFORMANCE GUARANTEE, TOLERANCE, PENALTY AND RECORDS**

11.01.00 The Tenderer shall have to guarantee the performance of individual equipment. The Tenderer shall also guarantee maintenance of the inside conditions as indicated under “design criteria”.

11.02.00 **Rectification of Deficient Performance**

If the shop / site performance tests indicate the failure of the guaranteed performance of the equipment concerned, the tenderer will be given sometime to make good the deficiency at his own cost by incorporating the necessary modification, alteration and replacement.

11.03.00 **Test Records**

The certificates and records of the above mentioned tests should be submitted to the Purchaser for approval. The manufacturer shall maintain records of all tests required in the specification for at least 5 years. A list of records shall be submitted to the Purchaser on completion of the job. The Purchaser shall be able to obtain certified copies of such records at any time.

12.00.00 SPECIAL CLEANING, PROTECTION & PAINTING

12.01.00 Internal surface of all parts shall be cleaned to remove loose scale and dirt. The external surface of the motor and end shield shall be sand blasted to remove all rust, scale etc. All sharp edge shall also be removed. Welded rods, studs and other foreign objects shall be removed prior to final assembly. Excess oil and grease shall be removed by wiping.

12.02.00 All parts shall be painted with two (2) coats of rust preventing paint. One (1) cost of final paint shall be applied over and above the rust proof paint before despatch of material.

12.03.00 All equipment shall be boxed / created or otherwise protected for shipment. Dry nitrogen desiccant and other protection shall be provided as may be necessary.

13.00.00 DOCUMENTS, DATA TO BE FURNISHED WITH TENDER PROPOSAL

13.01.00 Beside submitting the enclosed Proposal Exhibit Sheets duly filled in, the proposal shall also include the following drawings, curves and information wherever applicable.

Preliminary cooling and heating load calculation is to be furnished.

13.02.00 Preliminary equipment layout drawings of the air conditioning plant room, AHU room and preliminary ducting layout drawing are to be furnished.

13.03.00 Manufacturer's catalogue and literatures incorporating outline and sectional drawings and ducting data for the following equipment:

Screw Compressor
Water-cooled Condensers
Chiller
Air Handling Unit (Fan, cooling coil & filter)
Drive motors for various equipment as applicable
Condenser cooling & chilled water pumps
Cooling tower
Non chemical water treatment

Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct able Split Air-conditioner
Fan Coil Unit
Motor
Direct Digital Controller

13.04.00 Manufacturer's selection chart for the following equipment:

Water-cooled Screw Chiller
AHU
Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Unit
Pump
Cooling Tower
Fan
Fan Coil Unit

13.05.00 Manufacturer's catalogues and literatures on air conditioning system, instruments and controls.

13.06.00 Sectional drawings for air diffusers and grilles, as applicable.

13.07.00 Manufacturer's data sheets for filters and refrigerant.

13.08.00 Drive list

13.09.00 A detailed experience list about supply for system of similar type for similar application mentioning in each case the salient technical parameters, date of commissioning and name of customers.

13.10.00 A comprehensive write-up and / or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.

13.11.00 Any other relevant data and particulars.

14.00.00 **POST AWARD DOCUMENTS, DATA TO BE FURNISHED**

14.01.00 Description of the system offered.

14.02.00 Sizing calculations for all equipment and accessories which include cooling and heating load calculations, system pressure drop calculations, duct sizing calculations, pump capacity calculation, calculations for AHUs/FCUs and fresh air fans.

14.03.00 Particulars of drawings, data, instruction manual and Drive List.

14.03.01 Equipment layout drawing for

Packaged Screw Chiller
Air conditioning plant room
Air handling unit room
Cooling Tower
Pump
Expansion Tank
Make-up Water Tank
Water-cooled precision air conditioner

Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Unit
Fan Coil Unit

14.03.02 Schematic flow and instrumentation diagram of the complete system indicating the limits of supply and erection.

14.03.03 Ducting layout drawing showing the details of duct sizes, duct joints, duct insulation, duct supports, diffusers, grilles, dampers etc.

14.03.04 Layout drawings showing the route of Steam piping, refrigerant piping and cooling water piping with details of insulation hangers, supports etc.

14.03.05 Outline drawings incorporating all principal dimensions, civil foundation drawings and weight etc. and also sectional drawings incorporating data of material of construction wherever applicable for following equipments:

Water-cooled Screw Chilling Unit
Air handling unit
Water-cooled precision air conditioner
Air-cooled precision air conditioner
Air-cooled Non Duct-able Split Air conditioner
Drive motor for above equipment as applicable
Cooling tower
Expansion tank
Make-up Water Tank
Fan coil unit

14.03.06 Drawings and data sheets of each of Equipment and Instruments.

14.03.07 Drawings and data sheets for air filters, refrigerant / filter drier.

14.03.08 Write up on system interlock and / or interlock block diagram.

14.03.09 Electrical schematic and wiring diagram for control panel and the system as applicable with back-up write-up.

14.03.10 Control panel / Switchgear outline drawings, bill of instruments and drawings showing construction of control panel / switchgear.

14.03.11 Reflected False Ceiling Plan indicating detail of supports/ hangers, grids, fixing detail of Grilles and diffusers and lighting fixtures etc.

14.03.12 Fixing/ application detail of under deck insulation indicating type and thickness and weight of insulation.

14.03.13 Other drawings and data.

14.03.14 Material test certificates.

14.03.15 Shop test reports and certificates.

14.03.16 0peration, maintenance and overhauling manuals shall be provided as per following specification.

OPERATION AND MAINTENANCE MANUAL

The successful tenderer, shall prepare, during the project execution stage a manual giving details of operation and maintenance instructions. The manual will be comprehensive manual and will be provided by the Engineer. The manual shall cover but not limited to the following aspects:

i) Equipment description with design particulars.
ii) Installation and Maintenance Instruction including preventive maintenance requirements.
iii) Instruction for pre-commissioning check-up, operation.
iv) Trouble shooting.
v) Spare Parts list.
vi) Lubricant and lubrication schedule
vii) Control logic and inter connection and calibration of controls.
viii) System description
ix) Necessary drawings, illustration
x) List of manufacturer's name and catalogues
xi) Safety instructions.

The manual shall be securely bound in hard back durable folder with proper indexing and separators.

15.00.00 List of Drawings

Sl. No.	Drawing No.	Description
01.	13A06-003-DWG-VA-001	Schematic Diagram of Package Screw Chiller Unit
02.	13A06-003-DWG-VA-002	Schematic Diagram of Water Cooled Precision Air Conditioner
03.	13A06-003-DWG-VA-003	Schematic Diagram for Common Chilled Water Type Air

		Conditioning System of Power House and Service Building
04.	13A06-003-DWG-VA-004	Schematic Diagram of Air Cooled Precision Air Conditioner
05.	13A06-003-DWG-VA-003	Schematic Diagram of Air Cooled Split AC Unit

Annexure III
to
Technical Specification for Air Conditioning System of Switchyard Control building (Sec-II, Sub Section-C1)

VOLUME: V-A

SECTION-VII

TECHNICAL SPECIFICATION FOR 415V PMCC/MCC, 415V ACDB AND 220V DCDB

THIS ANNEXURE IS TSGENCO TS FOR ENTIRE PLANT. BIDDER SHALL REFER THIS TS FOR THE PORTIONS RELEVANT TO PDB FOR AC SYSTEM APPLICABLE FOR SWITCHYARD SCOPE ONLY.

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TYPICAL CONTROL SCHEMATIC

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SECTION-VII

TECHNICAL SPECIFICATION FOR 415V PMCC/MCC, 415V ACDB AND 220V DCDB

1.00.00 SCOPE OF SUPPLY

1.01.01 Requisite nos. of following equipment shall be furnished with all accessories :-

a. Power cum Motor Control Centre (PMCC)
b. Motor Control Centres (MCC)
b. A.C. Distribution Board (DB)
c. D.C. Distribution Board (DB)
d. D.C. Starters
e. Lockout Switches
f. A.C./D.C. fuse boards

1.01.02 The base channel frame with hardware and lifting angles.

1.01.03 One set of special tools and tackles.

1.01.04 Set of accessories as listed below :

a) Breaker lifting and handling trolley.

b) Test cabinet with coupling cables for testing the breaker in drawout position.

c) Racking in/out handle for breakers.

1.01.05 12kV rubber mats shall be provided both at front and rear of LT Switchgear.

1.01.06 Mandatory Spare parts.

1.01.07 All relevant drawings, data and instruction manuals.

2.00.00 CODES AND STANDARDS

2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.01.02 Equipment and material conforming to any other international standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 **DESIGN CRITERIA**

3.01.00 The PMCCs/MCCs/DBs will be used to provide power, control and protection for 415/240V A.C. and 220V D.C. auxiliary services (Motors & Feeders) of generating units.

3.02.00 Duty involves direct-on-line starting of large squirrel cage motors below 175kW. The starting current varies from 6 to 8 times rated current at very low power factor.

3.03.00 The equipment will be located in a hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.04.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values stipulated in relevant standards and/or this specification.

3.05.00 Equipment ratings and quantities are detailed in the enclosed drawings and annexure. Equipment shall be furnished in strict compliance with the same.

3.06.00 All equipment and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents without any damage or deterioration of the materials.

3.07.00 The PMCCs/ MCCs / DBs shall have two incomers and one bus-coupler. In addition to electrical interlocks, mechanical castle key interlock shall be provided between the two incomers and the bus-coupler so that any two of the three may be closed at a time.

3.08.00 Busbars of PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20% margin.

Busbars of MCC/DBs shall be sized to carry continuously the total running load of MCC/DB plus a 20% margin.

3.09.00 In cubicle of incomers & bus section breakers/MCCBs shall be identical to the associated busbar rating.

3.10.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values specified in relevant standards and/or this specification.

3.11.00 Circuit breakers shall not produce any harmful over voltage during switching off of induction motors. If required, surge protective devices shall be included in the scope of supply to limit over voltages.

3.12.00 Incomers, Bus-couplers & outgoing feeders rated upto & including 630A shall be MCCB controlled. Above 630A all incomers, Bus-couplers & outgoing Feeders shall be ACB controlled. For critical loads ACB controlled feeders shall be provided which will be decided during detail engineering.

3.13.00 All motor rated 110kW & above, below 175kW shall be ACB controlled. Motor rated upto 110kW shall be contactor operated.

3.14.00 MCC & PMCC shall have sufficient number of spare modules (at least 20% of various sizes used with a minimum of 1 no. for each rating and type).

3.15.00 Outgoing feeders of PMCC shall be limited to minimum number of different sizes so that max. standardization is achieved from MCCB & contactor size point of view.

3.16.00 Incomers & bus section breakers of PMCCs/MCCs shall have provisions for remote operation from control room.

3.17.00 All breaker operated motor feeder shall be supplied from PMCC.

3.18.00 One no. Normal/Emergency switchgear to cater power supply to important emergency load / motors for safe shut-down of unit including 220V battery chargers shall be provided for each unit. The main incoming supply shall be from 415V unit service switchgear. When main incoming supply fails, reserve incoming supply shall be switched ON automatically from 415V station service switchgear. In case of total failure of AC supply of the power station, the supply from DG shall be switched ON automatically.

3.19.00 Each switchgear shall be provided with two bus sections, two incomer and a bus coupler rated for 100% of the loads connected to the switchgear.

3.20.00 For each auxiliary or load, one feeder shall be provided except for the following cases:

One feeder for a maximum 2 nos. isolator motor operating mechanism.

3.21.00 The switchgears shall be provided with suitable number and type of outgoing feeders for the respective auxiliary loads of the system/area, power supply feeders to various panels, lighting transformer, space heating panels, control cabinets and all other loads encountered in the plant. In addition, following feeders shall be provided in each bus section of each switchgear.

a) Bus VT module: One (1) no.

b) Switchgear test supply module: One (1) no.

c) 240V, 1 phase essential supply module with five nos. 1 phase outlets: One (1) no.
Necessary 415V/240V dry type transformer shall be provided.

d) Alarm module for common alarm for outgoing feeder fault: One (1) no.

e) DC supply alarm module for incomer, bus coupler fault: One (1) no.

3.22.00 Each feeder shall be provided with two nos. interposing relays for start & stop. These interposing relays shall be located in separate IPR panel described under C&I specification.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **Construction**

4.01.01 PMCC / MCC / DB shall be indoor, metal-clad, air insulated and floor mounting type. All MCCs shall be fully draw out type and DBs shall be fixed type. ACB modules of PMCCs/MCCs shall be fully drawout type. MCCB / Switch Fuse modules shall also be fully drawout type. The design and construction shall be such as to allow extension at either end.

4.01.02 All PMCC/MCC shall be of double front construction.

4.01.03 PMCC /MCC/DB enclosure shall be dust and splash proof, conforming to a degree of protection IP-54. All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness 2.0mm. Frames shall be enclosed in cold rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot/cold rolled sheet steel and 4.0 mm for non-magnetic material.

4.01.04 PMCC / MCC / DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multi tier formation.

4.01.05 The design shall be fully compartmentalized with metal/insulating partitions between compartments. The working height shall be limited within 750 mm to 1800 mm from floor level.

4.01.06 Each control module shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section shall have a removal back cover. All doors and covers shall be gasketed.

4.01.07 All push buttons, lamps, indicating instruments shall be flush / semi-flush mounted on respective module compartment.

4.01.08 A full height vertical cable chamber with cable supports shall be provided in each section to facilitate unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

4.01.09 A horizontal wireway, extending the entire length, shall be provided at the top of each PMCC / MCC / DB for inter panel wiring.

4.01.10 The width of the cable alley shall not be less than 250 mm.

4.02.00 **Bus and Bus Taps**

4.02.01 All PMCCs/MCCs/DBs shall be provided with three phase & neutral bus bars . All DCDBs shall be provided with two busbars. All busbar compartments shall be completely enclosed.

4.02.02 The main buses and connections shall be of high conductivity Aluminium / Aluminium alloy, sized for specified current ratings with maximum temperature limited to 85^{o}c (i.e., 35^{o}C rise over 50^{o}C ambient).

4.02.03 Vertical busbars shall be designed for minimum current rating of 200A. Separate vertical busbars shall be provided for each vertical panel.

4.02.04 All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two-bolt connection with plain and spring washers and locknuts.

Bimetallic connector shall be furnished for connection between dissimilar metals.

4.02.05 Busbars and connections shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and shrouds for joints and tap-off points shall be provided.

Bus insulators shall be flame retardant, non-hygroscopic track-resistant type with high creepage surface.

4.02.06 Busbars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.

4.02.07 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear when viewed from the front of the assembly.

4.03.00 **Control Modules**

4.03.01 Draw-out type control module shall have self-aligning power/control disconnects. All disconnects shall be silver plated to ensure good contacts.

4.03.02 The design shall be such as to permit easy withdrawal/reinsertion of the unit with guide rails to ensure correct alignment.

4.03.03 Control Module shall house the control components for a circuit such as switch fuse / MCCB, contactors, relays, push buttons, lamps etc. as per requirement of the control circuit.

4.03.04 The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.

4.03.05 Various module/compartment sizes shall be multiple of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical bus bars.

4.03.06 Draw-out type control modules of same size and type shall be electrically and physically interchangeable.

4.04.00 **Air Circuit Breaker**

4.04.01 Circuit breaker shall be provided on the incomer having minimum interrupting capacity equal to the 50kA(r.m.s) fault level.

4.04.02 Circuit breaker shall be three pole, single throw, air-break type with independent manual spring closing, trip-free mechanism and shunt trip. However Incomer breaker shall be four pole type.

4.04.03 Circuit breaker shall be draw-out type, having service, test & isolated position with positive indication for each position.

4.04.04 Circuit breakers of identical rating shall be physically and electrically interchangeable.

4.04.05 Each breaker shall be provided with microprocessor based protection unit having three overload protection with adjustable current and time, three short circuit protection with adjustable current and time and three instantaneous short circuit protection. The operating characteristic shall be suitable for co-ordination with down-stream fuses.

4.04.06 Circuit breakers shall be provided with motor wound spring charging mechanism. Spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor. In addition, facility for manual charging of spring shall be provided.

4.04.07 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed. It shall not be possible to open the circuit breaker door cubicle unless the breaker is in 'OFF' position.

4.04.08 Automatic safety shutters shall be provided to cover up the stationary disconnects when the breaker is withdrawn.

4.04.09 Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF indicator, an operation counter and spring mechanism charge/discharge indicator, and electrical anti-pumping feature.

4.04.10 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with the following for interlocking purpose :-

a. Position/Cell switch with 4 NO + 4 NC contacts.

b. Auxiliary switch, with minimum 6NO + 6NC contacts,

4.04.11 Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches shall be provided with minimum 2NO + 2NC contact.

4.04.12 Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.

4.04.13 Each breakers operated feeder shall be provided with protective devices as specified in Annexure–B.

4.05.00 **Switches**

4.05.01 Switches shall be triple pole, air break, AC23 motor duty for motor feeders and AC22 heavy duty for other feeders.

Motors duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.

4.05.02 The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.

4.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

4.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.

4.05.05 Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of the three can be closed at time.

Wherever two incoming switches are provided for an assembly, these shall be mechanically/key interlocked to ensure that one of the two can be closed at time.

4.05.06 All incoming and outgoing feeders shall be provided with bolted disconnect link for isolation of neutral if necessary.

4.06.00 **Fuses**

4.06.01 Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the short circuit current of the LT system. Fuses shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of base. In such cases, one set of insulated fuse pulling handles shall be supplied with each board.

4.06.02 Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element.

Visible indication shall be provided on blowing of the fuse.

4.06.03 Motor fuse characteristics and ratings shall be chosen to ride over starting period without blowing. The fuse on incoming feeder wherever provided, shall be chosen to provide discrimination with motor/feeder fuses.

4.07.00 **Moulded Case Circuit Breaker (MCCB)**

4.07.01 The MCCBs shall be of drawout type with trip-free operating mechanism of quick make & quick break type. Each MCCB shall be equipped with thermal release for thermal overload and magnetic release for short circuit protection on each pole.

4.07.02 MCCBs / MPCBs shall be suitable for manual closing and opening and also automatic trip on overload and short circuit. MCCB shall have intermediate position to indicate trip condition.

4.07.03 The MCCBs shall be provided with mechanical ON-OFF indicator at the front panel. The MCCB handles, after the breaker tripped due to faults, shall occupy a mean position indicating trip condition.

4.07.04 The compartment door shall be interlocked mechanically with the MCCB such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for releasing this interlock at any time.

4.07.05 All feeders of PMCC / MCC rated up to & including 630 Amp shall be provided with MCCB. Air circuit breaker shall be provided for feeders rated above 630 Amp. For critical loads ACB controlled feeders shall be provided which will be decided during detailed engineering.

4.07.06 Motors rating above 110 KW will be operated by Air circuit breaker and protected by consolidated numerical motor protection relay.

4.08.00 **A.C. Starter**

4.08.01 Contactors

a. The contactors shall be three pole, air break type designed for duty class III - Category AC3 (for unidirectional motor) with non-bouncing silver/ silver alloy contacts. Contacts for reversible motors will be of AC4 duty.

b. Each contactor shall be provided with minimum two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V A.C.

c. Reversing contacts shall be electrically and mechanically interlocked.

d. Contactors with delayed dropout feature shall be provided for some essential auxiliaries. These contactors shall not dropout on power failure if the voltage is restored within 3 seconds.

4.08.02 **Protection**

a. Thermal overload relays shall be three element, positive acting, ambient temperature compensated with adjustable settings.

b. Single phase preventor relay shall be provided, preferably as an inbuilt feature of thermal overload relay.

c. Relays shall be manual reset type with two changeover potential-free contacts. Resetting of relays shall be possible with compartment door closed. Colour of the resetting button shall be BLACK.

d. Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply.

e. Motor starters shall have type '2' co-ordination according to IEC 947-4.

f. Earth fault relays with adjustable settings and time delays fed from core balance CT shall be provided.

g. Numerical / Digital Motor protection relay with short circuit, over load, earth fault, locked rotor and unbalance (NPS) load protection functions shall be provided for motor rated above 90 kW.

4.09.00 **Control Transformer**

4.09.01 LT Switchboard control supply

The Bidder shall provide one (1) no. adequately rated 415V/110V Control Transformer in each bus section with necessary taps and auto changeover facility for providing control power supply to various modules of the board, except motor feeders. Each motor feeder shall be provided with 415/110V control transformer of adequate capacity (min. 75VA) for control supply to such module. The sizing of control transformer shall be carried out by the Bidder considering the actual load of power contactors, auxiliary contactors, indicating lamps and other equipment in the module circuit. An additional load of 15watts shall be considered for each module for remote auxiliary relays and lamps to be connected in the control circuit of modules. Bidder shall also ensure that control transformer are adequately designed for meeting the momentary loading requirements and the voltage drop during this condition shall not be more than 5%. Each transformer shall be sized for catering to control supply of both bus sections.

4.09.02 LT Switchboard space heater supply

The Bidder shall provide one (1) no. adequately rated 415V/240V Control Transformer in each bus section with necessary taps and auto changeover facility for providing power supply to panel space heater, Motor space heater of motor rated 30 KW & above, Panel Illumination & Socket. The supply of these two (2) nos. control transformer are tapped from incoming supply of 415V PMCC/MCC before the incoming breaker. Incoming circuit to the space heater auxiliary bus shall be through isolating switch HRC fuse and neutral link of suitable rating. The supply of different modules shall be tapped individually from the auxiliary bus bars. Control supply healthy indication shall be provided. Each transformer shall be sized for catering to space heater supply of both bus sections.

4.10.00 **D.C. Starters**

4.10.01 D.C. Starter for emergency oil pump shall be fixed resistance type, designed to provide fast acceleration during starting.

4.10.02 DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push-buttons, lamps, etc.

4.10.03 Starters shall be furnished in totally enclosed floor-mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2mm.

4.10.04 The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54.

The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.

4.10.05 Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.

4.11.00 **Relays**

4.11.01 All incoming and bus-coupler circuits and circuit breaker operated outgoing feeders shall be provided with numerical relays. Breaker operated motor feeders shall be provided with numerical motor protection relay.

4.11.02 The numerical relays shall have provisions for interfacing with Plant DDCMIS / PLC.

4.11.03 Relays shall be of drawout design with built-in testing facilities. Small auxiliary relays may be in non-drawout execution.

4.11.04 All protective relays, auxiliary relays, and timers shall be provided with hand reset operation indicator (flag).

4.11.05 Relays shall be rated for operation on 110V secondary voltage and 5 A or 1 A. Number and rating of relay contacts shall suit the job requirements.

4.12.00 **Control and Indication**

4.12.01 Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following :

i) One (1) TEST-NORMAL-TRIAL selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism.

ii) On-Off control switches shall have three positions (T-N-C) and shall be spring return to 'Neutral' from close and trip positions. They shall have two contacts closing in close position and two contacts closing in trip positions, and shall have Pistol Grip handles. Lost motion feature shall be provided wherever required.

iii) Following indicating lamps on the front of the compartment:

Breaker open	-	GREEN
Breaker closed	-	RED
Breaker tripped	-	AMBER
Spring charged	-	WHITE
Trip Ckt. Healthy	-	BLUE

Motor Space heater ‘ON’ for motor circuit - YELLOW

4.12.02 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.

4.12.03 Each push button shall have minimum two (2) nos. normally open and two (2) nos. normally closed contacts rated 10 A at 240 V.

4.12.04 One (1) NORMAL-TRIAL selector switch shall be provided for all motor feeders.

4.12.05 Selectors switches shall be stay-put, rotary type with escutcheon plates marked to indicate the function and positions, and shall be lockable in each position. Selector switch contacts shall be rated for 10A at 240 V A.C.

4.12.06 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.

The exact requirements of contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.

4.12.07 Lamps shall be clustered LED type with series resistor and coloured lens. Lens and lamps shall be replaceable from the front. Lamps shall be located just above the associated push button/control switch

4.12.08 The general scheme of connections for control, interlock and protection is shown in the enclosed drawings. Detailed requirements of individual circuits will be intimated later to the successful bidder, who shall develop and furnish the schemes accordingly.

4.13.00 **Meters**

4.13.01 All indicating instruments (96 x 96 mm) shall be switchboard type, with 250` scale, anti-glare glass and accuracy class of ± 2% full scale. Each meter shall have zero adjuster on the front.

4.13.02 Motor ammeter shall be suitable to indicate starting current (6 to 8 times full load current) for DOL starting of motor.

Motor ammeter shall be provided for motor rated 30 kW and above and for critical drives, to be finalized during detail engineering.

4.13.03 All incomers, tie feeders, circuit breaker operated motor feeders shall be provided with 3-phase multifunction meter with pulse output and communication port for interfacing with Plant DDCMIS / PLC.

4.13.04 Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.

4.14.00 **Current Transformer**

4.14.01 Current Transformer, shall be cast resin type rated 10 VA. All secondary connections shall be bought out to terminal blocks where wye or delta connection will be made.

4.14.02 Accuracy class of the current transformers shall be:

a) Class PS for REF

b) Class 5P20 for other relaying.

c) Class 1.0 ISF < 5 for metering.

d) Class 0.5 ISF < 5 for metering (Incomer & Bus coupler of PMCC)

Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the bidder.

4.14.03 CT secondary shall be rated for 1A for metering & either 5A or 1A for protection.

4.15.00 **Voltage Transformer**

4.15.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For Incomer and bus coupler of PMCC accuracy class of voltage transformer shall be 0.5.

4.15.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.

4.15.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.

4.15.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.

4.16.00 **Transducers**

4.16.01 Transducer for conversion of AC electrical quantities such as voltage, current, KW etc. shall be supplied as required for remote connection to Plant DDCMIS / PLC. All transducers shall be dual output type.

4.16.02 The transducers for indicating type instruments shall be of very low burden type having 4-20 mA DC linear, galvanically isolated output, compatible with secondary instruments and Plant DDCMIS system.

4.17.00 **Secondary Wiring**

4.17.01 The PMCC/MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection and interlocking schemes.

4.17.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, push buttons and other devices shall be wired upto terminal blocks.

4.17.03 Wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated switchboard wires with stranded Copper conductors of 2.5 mm^2 for control & current circuits and 1.5 mm^2 for voltage circuits.

4.17.04 Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring diagrams.

4.17.05 Wire terminations shall be made with crimping type connector with insulating sleeves. Wires shall not be spliced between terminals. Separate colour code shall be used for AC & DC circuit wiring for easy identification.

4.18.00 **Terminal Blocks**

4.18.01 Terminal blocks shall be 1100V grade box-clamp type with marking strips similar to ELMEX 10 mm^2 or equal. Terminals for C.T. secondary leads shall have provision for shorting.

4.18.02 Terminal blocks used for interface with DDCMIS / PLC via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

4.18.03 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

4.18.04 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

4.19.00 **Cable Terminations**

4.19.01 PMCC shall be designed for cable entry from bottom. MCC/DB shall be designed for cable entry both from top and bottom. Actual configuration shall be intimated later sufficient space shall be provided for ease of termination and connection.

4.19.02 Power cables shall be 1100V, Copper/Aluminum conductor, XLPE insulated, armoured, FRLSH PVC overall sheathed.

Control cables shall be 1100V, PVC insulated, armoured, PVC overall sheathed with 2.5 mm^2 stranded Copper conductor.

4.19.03 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned Copper/Aluminium lugs, brass compression glands with tapered washer (Power Cables only) and Terminal blocks.

4.19.04 Sufficient space shall be provided between the lower most power cable termination and gland plate for easy cable connection.

4.20.00 **Bus Duct Connection**

4.20.01 Bus duct connections shall be furnished along with transition panel, if required. Unless mentioned otherwise bus duct connections shall generally be from the top.

4.20.02 All connecting bus work shall have the same continuous current rating as associated PMCC bus and shall be fully braced for the LT system short circuit current.

4.20.03 All provisions such as matching flange and other accessories shall be furnished for connection to bus duct.

4.21.00 **Ground Bus**

4.21.01 A Cu / Al ground bus rated to carry the maximum fault current, shall extend full length of the MCC/DB.

4.21.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts & nuts at each end to receive 50 x 6 mm G.I. flats.

4.21.03 All stationary structures shall be directly connected to the ground bus for effective grounding.

4.21.04 The frame of draw out module shall be grounded at all times except when the power disconnects are separated by a safe distance.

4.21.05 All hinged doors shall be earthed through flexible copper braid wire.

4.22.00 **Nameplate**

4.22.01 Nameplate of approved design shall be provided for each control compartment and also at the top of each PMCC / MCC / DB.

4.22.02 The material of the name plate shall be anodized aluminium / lamicoid or approved equal, 3 mm thick, with white letter on black background. Name plates shall be minimum 20 x 75 mm for instrument / devices and 40 x 150 mm for panels.

4.22.03 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

4.23.00 **Space Heater**

4.23.01 Panel and motor space heater shall be fed from separate AC auxiliary busbars running throughout the switchboard. The space heater bus shall be fed from control transformer described earlier. Suitable terminals shall also be provided to facilitate energisation of the control transformer from outside during long shutdown of the board.

4.23.02 Each vertical section of the PMCC / MCC / DB shall be furnished with thermostat controlled space heater and 5A, 5 pin plug socket.

4.23.03 In addition, motor feeders 30 KW and above shall be wired up for feeding motor space heater through starter auxiliary ‘OFF’ contacts.

4.23.04 Cubicle heater, Motor heater and plug socket circuit shall be provided with individual MCB/switch fuse units.

4.24.00 **A.C./D.C. Power Supplies**

4.24.01 Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C. supply and duplicate feeder shall be arranged for D.C. supply.

4.24.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C. Molded case circuit breaker (MCCB) shall also be accepted as an alternative.

4.24.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units / MCCB shall be provided at each cubicle for A.C/D.C. supplies.

4.24.04 A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.

4.25.00 **Tropical Protection**

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

4.26.00 **Painting**

4.26.01 All steel surfaces shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.

4.26.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.

4.26.03 For paint shade of finish coat, refer clause no.1.16.00 of Section E1, Volume V-A.

4.26.04 Sufficient quantity of touch-up paint shall be furnished for application at site.

4.26.05 Caution notice plate shall be affixed at the back of each vertical panel.

5.00.00 **TESTS**

5.01.00 All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

5.02.00 **Routine Test**

The tests shall include but not necessarily be limited to the following :-

a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b. All wiring and current carrying part shall be given appropriate High Voltage Test.

c. Primary current & voltages shall be applied to all instrument transformers.

d. Routine test shall be carried out on all equipment such as circuit breakers, switch - fuse, contactors, relays, meters etc.

5.03.00 **Type Tests**

The type test certificates for the following tests carried out on an identical & similar type of switchgear shall be furnished. The date of tests shall be within the last five years.

a. Temperature rise Test

b. Short time current test on main circuit and earth circuit.

c. Verification of making and breaking capacity.

Type test certificates of any equipment shall be furnished if so designed by the purchaser/ owner. Otherwise the equipment shall have to be type tested free of charge, to prove the design. Type test performed before five (5) years are not acceptable.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

6.02.00 **To be submitted with the bid** :-

a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points etc.

b. Typical foundation plan

c. Typical control schematic

d. Bill of materials

e. Type test reports on circuit breaker

f. Technical leaflets on :-
   i) Circuit breaker
   ii) Switch-fuse units
   iii) Contactors
   iv) Relays, meters, push buttons, selector switches etc.
   v) Glands/terminals blocks

6.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS AND REQUIREMENTS

1.0	General			
	Type	:	ACB Modules - Drawout type MCCB Modules – Drawout type	
	Service	:	Indoor	
	Enclosure	:	IP52	
2.0	System		AC	DC
	Voltage	:	415V ± 10%	220V (187-242V)
	Phase	:	3-phase, 4-wire	2- wire
	Frequency	:	50 Hz +3% to - 5%	
	Combined voltage and Frequency variation	:	10% (absolute sum)	
	System grounding	:	Solidly grounded	Ungrounded
3.0	Rating			
	Rated current	:	To be decided by the tenderers.	
	Design Ambient Temperature	:	50ºC	
	Short Circuit Current Symm.	:	50 KA	25* KA
	* Indicative only, the actual value will be decided by the tenderers.			
	S/C Withstand Time	:	---------- 1 second ----------	
	High voltage test for 1 minute	:	2.5 kV	1.5 kV
4.0	Duty			
	Circuit Breaker	:	0-3'-CO-3'-0	
	Contactor (AC)	:	Class III - Category AC3 for unidirectional drives and AC4 for bi-directional / inching duty drives	
	Contactor (DC)	:	Class I – category DC2	
	MCCB / Switch Duty for		AC	DC
	Motor Feeder	:	AC23	DC22

	Other Feeder	:	AC22	DC22
5.0	A.C. / D.C. Power Supply			
	Control Voltage for Circuit breaker	:	220V DC +10% to -15%	
	Control voltage for MCCB modules	:	110V AC ± 10%, 1Ph, 50Hz +3% to - 5%	
	Service voltage	:	240V AC ± 10%, 1Ph, 50Hz +3% to - 5%	

ANNEXURE-B

PROTECTIONS

1.0 All Protective relays shall be numerical type having communication facility with Plant DDCMIS system / PLC.

2.0 The minimum protections to be provided for different types of circuits are listed below:

a.	Incoming Feeder & Bus-coupler with ACB:	3	-	inverse time O/C relays (51) for phase fault.
		1	-	Inverse time O/C relay (51N) for Earth fault.
		3	-	Under Voltage (27), Range : 40-80% with timer
b.	Motor Feeder with ACB: (above 110 kW)	1	-	Composite Motor protection relay (99) for protection against
			-	Thermal overload
			-	Phase faults
			-	Unbalance (negative sequence)
			-	Locked rotor
			-	Excessive Start-up time and Start-Stop.
			-	Earth fault
c.	Outgoing Feeder with ACB :	3	-	Inverse time O/C relays (51) for phase fault.
		1	-	Inverse time O/C relay (51N) for Earth fault.

3.0 Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip circuit supervision (74) relays. Lockout relay shall be hand reset type.

4.0 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided..

5.0 For Auto-bus change-over as well as live bus change-over through synchronization refer enclosed Control Schematic drawings.

6.0 Each incomer shall be provided with three (3) nos. Bus Energised indicating lamps – Red/Yellow/Blue for each phase.

ANNEXURE-C

FITTINGS & ACCESSORIES

Each switchboard shall be furnished complete with fittings and accessories as listed below: -

1. Operating mechanism complete with all accessories, fittings and tripping coil and closing coil, pole discrepancy feature etc. as required.
2. Base frame and anchor bolts and nuts.
3. Auxiliary contacts and relays.
4. LOCAL/REMOTE Selector switch, TRIP/CLOSE Push Buttons.
5. Manual tripping devices with protective flap.
6. Mechanical ON-OFF indicator.
7. Operation counters.
8. Set of switch fuse units/MCCB for A.C. and D.C. supply.
9. Space heater with thermostat and ON-OFF switch.
10. Cubicle illumination lamp with ON-OFF switch.
11. 3 Pin 5A Socket with ON-OFF Switch.
12. Terminal blocks and internal wiring - lot as required.
13. Other standard accessories which are not specifically mentioned but supplied with breakers of similar type and rating for efficient and trouble-free operation.

14. Bimetallic terminal connectors.

ANNEXURE-D

BUS TRANSFER SCHEME FOR PMCC

1.0 The manual bus transfer shall be arranged in such a way that any of the following modes of operation is possible.

1.1 **Manual Bus Transfer**

a) Without voltage interruption

This means by allowing momentary parallel operation of two sources.

b) With voltage interruption

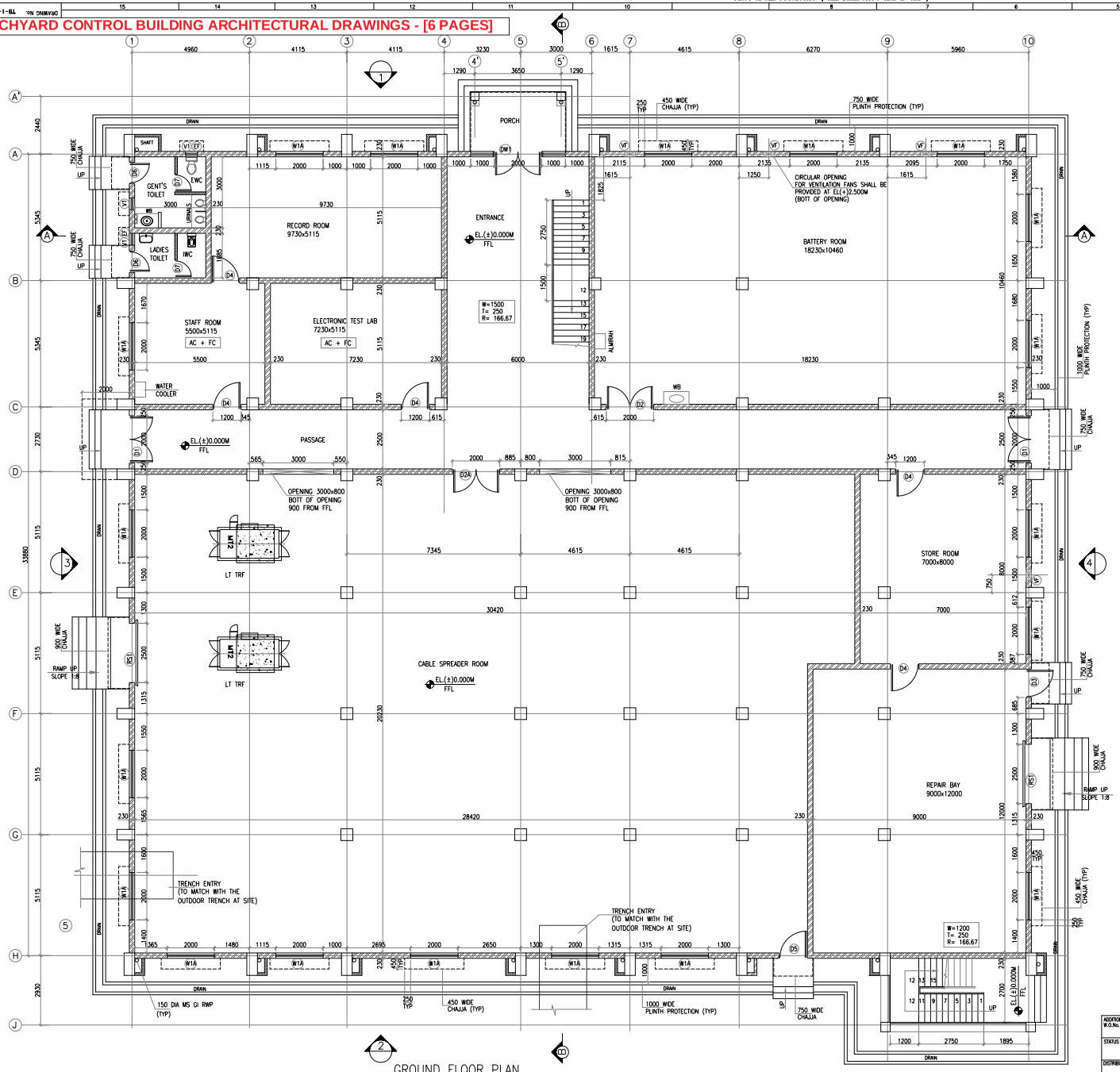
i) Slow Transfer

ii) Fast Transfer

NOTE : For CHP/AHP system 'Manual bus transfer without voltage interruption' and 'dead bus transfer with voltage interruption' shall be provided.

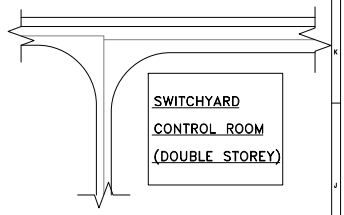
Synchronization of Incomer & Bus coupler for each of the 415V PMCC shall be implemented through PLC in CHP electrical cum control room building. Synchronization check relay, guard relay and auxiliary relay shall be provided in each PMCC. Synchroscope along with cut off switch, double voltmeter, double frequency meter shall be provided in the Main CHP electrical building cum control room. Separate synchronization switch and trip selector switch for each of the PMCC shall also be provided in the CHP electrical building cum control room.

SWITCHYARD CONTROL BUILDING ARCHITECTURAL DRAWINGS - [6 PAGES]



GROUND FLOOR PLAN

NORTH



KEY PLAN

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
3. ALL DOOR-WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.
4. EL(±)0.00M SHALL BE READ AS GROUND FLOOR FINISHED LEVEL OF SWITCHYARD CRB.
5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

SCHEDULE OF DOORS & WINDOWS

TYPE	OPENING SIZE	CILL LEVEL	LINTEL LEVEL	NOS.	DESCRIPTION
RS1	2500x3000	–	3000	2	STEEL ROLLING SHUTTER
DW1	4000x2500	–	2500	1	DOUBLE SHUTTER ALUMINIUM DOOR
D1	2000x2500	–	2500	5	DOUBLE SHUTTER ALUMINIUM DOOR
D2	2000x2500	–	2500	3	DOUBLE SHUTTER 2Hrs FIRE RATED DOOR
D2A	2000x2500	–	2500	1	DOUBLE SHUTTER LOUVERED DOOR
D3	1200x2500	–	2500	3	SINGLE SHUTTER ALUMINIUM DOOR
D4	1200x2100	–	2100	7	SINGLE SHUTTER ALUMINIUM DOOR
D5	1200x2500	–	2500	3	SINGLE SHUTTER 2Hrs FIRE RATED SINDOOR
D6	900x2100	–	2100	5	SINGLE SHUTTER WOODEN PANEL DOOR
D7	750x2100	–	2100	4	SINGLE SHUTTER PVC DOOR
W1	2000x1600	900	2500	15	ALUMINIUM GLAZED WINDOW
W1A	2000x1200	900	2100	19	ALUMINIUM GLAZED WINDOW
W2	1200x1400	900	2500	3	ALUMINIUM GLAZED WINDOW
V1	500x900	1600	2500	5	ALUMINIUM GLAZED VENTILATOR
FG1	3000x1600	900	2500	6	ALUMINIUM GLAZED WINDOW
FG2	4000x1600	900	2500	1	ALUMINIUM GLAZED WINDOW

LEGEND :-

RL	REDUCED LEVEL
FGL	FINISHED GROUND LEVEL
TRL	TOP OF ROAD
FFL	FINISHED FLOOR LEVEL
BOB	BOTTOM OF BEAM
TOC	TOP OF CONCRETE
TOP	TOP OF PARAPET WALL
PCC	PLAIN CEMENT CONCRETE
TOB	TOP OF BEAM
BOF	BOTTOM OF FALSE CEILING
FC	FALSE CEILING
UDI	UNDER DECK INSULATION
W/O	WITH OUT
WPC	WATER PROOF COURSE
RS	ROLLING SHUTTER
D	DOOR
W	WINDOW
FG	FIX GLAZING
EF	EXHAUST FAN
VF	VENTILATION FAN
WB	HAND WASH BASIN

230 THK. BRICK WALL

115 THK. BRICK WALL

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]
5X800 MW YADADRI THERMAL POWER STATION

CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION PROJECTS DIVISION

ADDITIONAL INFORMATION W.O.No. 85004

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	APPD	PLK	–	04.03.20

TITLE: ARCHITECTURAL PLAN OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

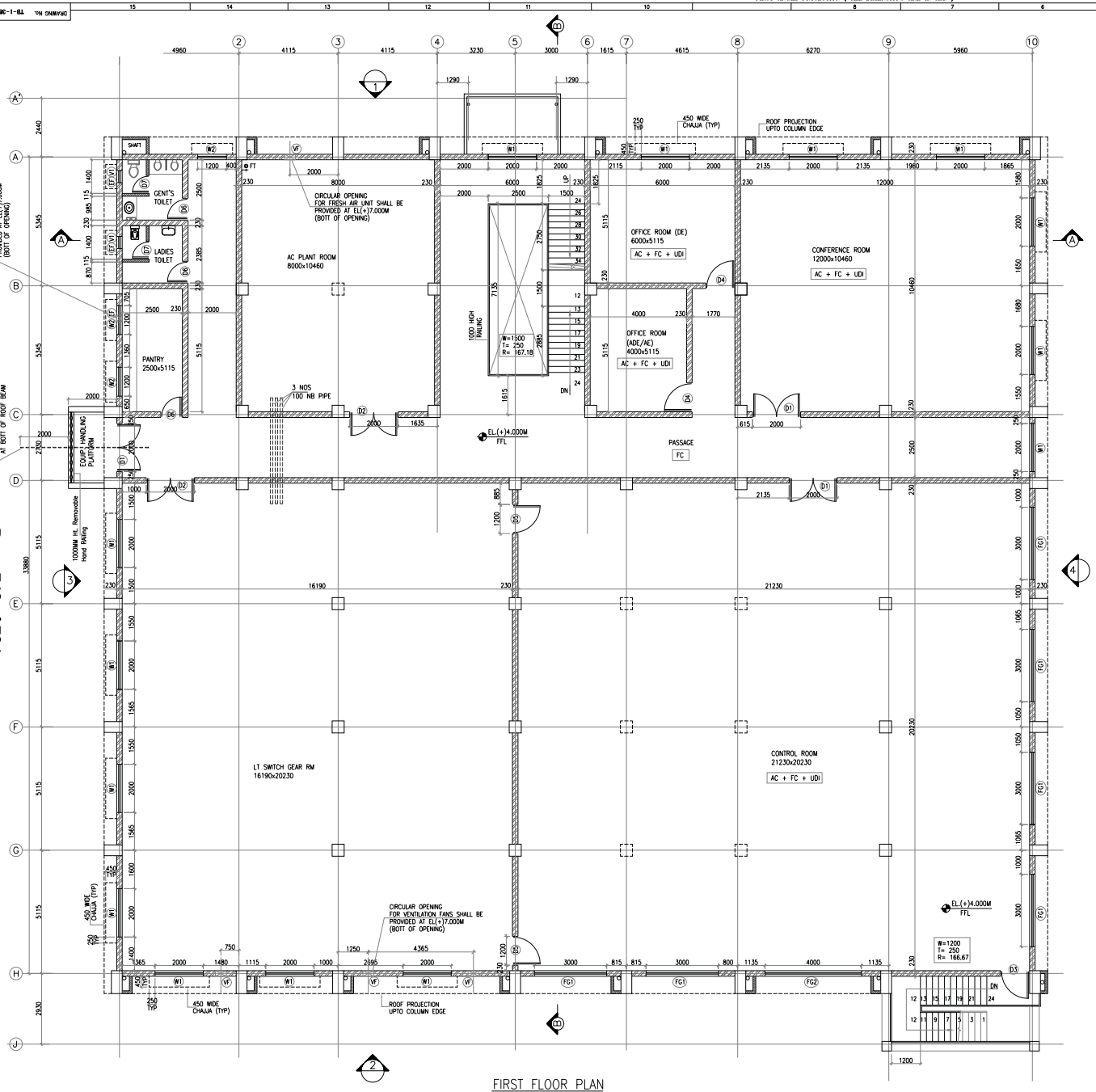
DEPT. SCALE 1:75 SIGN

DRAWING NO. BHEL TB-1-387-607-651

SHEET 01 OF 02 REV. 01

REV.	DATE	ALTERED CHECKED APPROVED	ZONE
R1	07.07.20	ALTERED TKR CHECKED DKU APPROVED PLK	

REVISED AS PER COMMENTS



FIRST FLOOR PLAN

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
3. ALL DOOR-WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.
4. EL(±)0.00M SHALL BE READ AS GROUND FLOOR FINISHED LEVEL OF SWITCHYARD CRB.
5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

SCHEDULE OF DOORS & WINDOWS

TYPE	OPENING SIZE	CILL LEVEL	LINTEL LEVEL	NOS.	DESCRIPTION
RS1	2500x3000	–	3000	2	STEEL ROLLING SHUTTER
DW1	4000x2500	–	2500	1	DOUBLE SHUTTER ALUMINIUM DOOR
D1	2000x2500	–	2500	5	DOUBLE SHUTTER ALUMINIUM DOOR
D2	2000x2500	–	2500	3	DOUBLE SHUTTER 2Hrs FIRE RATED DOOR
D2A	2000x2500	–	2500	1	DOUBLE SHUTTER LOUVERED DOOR
D3	1200x2500	–	2500	3	SINGLE SHUTTER ALUMINIUM DOOR
D4	1200x2100	–	2100	7	SINGLE SHUTTER ALUMINIUM DOOR
D5	1200x2500	–	2500	3	SINGLE SHUTTER 2Hrs FIRE RATED SINDOOR
D6	900x2100	–	2100	5	SINGLE SHUTTER WOODEN PANEL DOOR
D7	750x2100	–	2100	4	SINGLE SHUTTER PVC DOOR
W1	2000x1600	900	2500	15	ALUMINIUM GLAZED WINDOW
W1A	2000x1200	900	2100	19	ALUMINIUM GLAZED WINDOW
W2	1200x1400	900	2500	3	ALUMINIUM GLAZED WINDOW
V1	500x900	1600	2500	5	ALUMINIUM GLAZED VENTILATOR
FG1	3000x1600	900	2500	6	ALUMINIUM GLAZED WINDOW
FG2	4000x1600	900	2500	1	ALUMINIUM GLAZED WINDOW

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]
5X800 MW YADADRI THERMAL POWER STATION

CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

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TITLE: ARCHITECTURAL PLAN OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

DEPT. SCALE 1:75 SIGN

DRAWING NO. BHEL TB-1-387-607-651

SHEET 02 OF 02 REV. 01

REV.	DATE	ALTERED CHECKED APPROVED	ZONE
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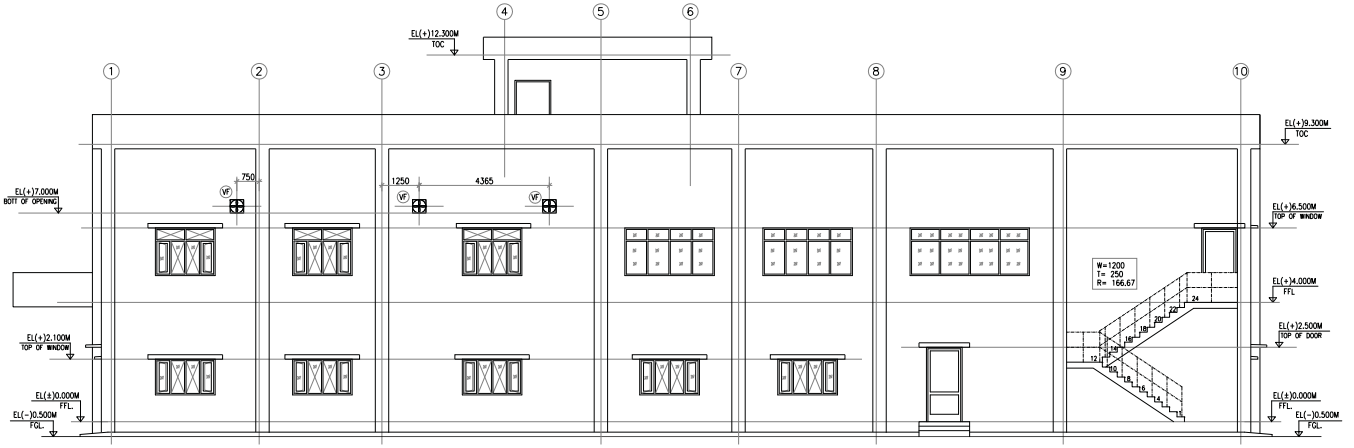
ELEVATION – 1



ELEVATION – 2

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
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4. EL(±)0.00M SHALL BE READ AS GROUND FLOOR FINISHED LEVEL OF SWITCHYARD CRB.
5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]
5X800 MW YADADRI THERMAL POWER STATION

CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
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TITLE
ARCHITECTURAL ELEVATIONS OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE
R1	07.07.20	ALTERED TKR / CHECKED DKU / APPROVED PLK	

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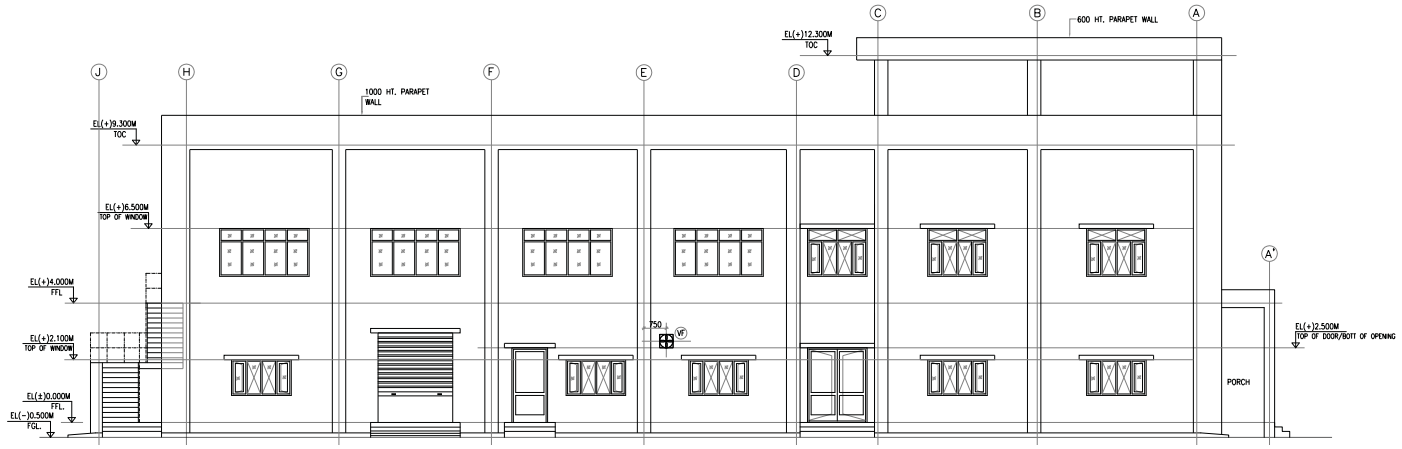
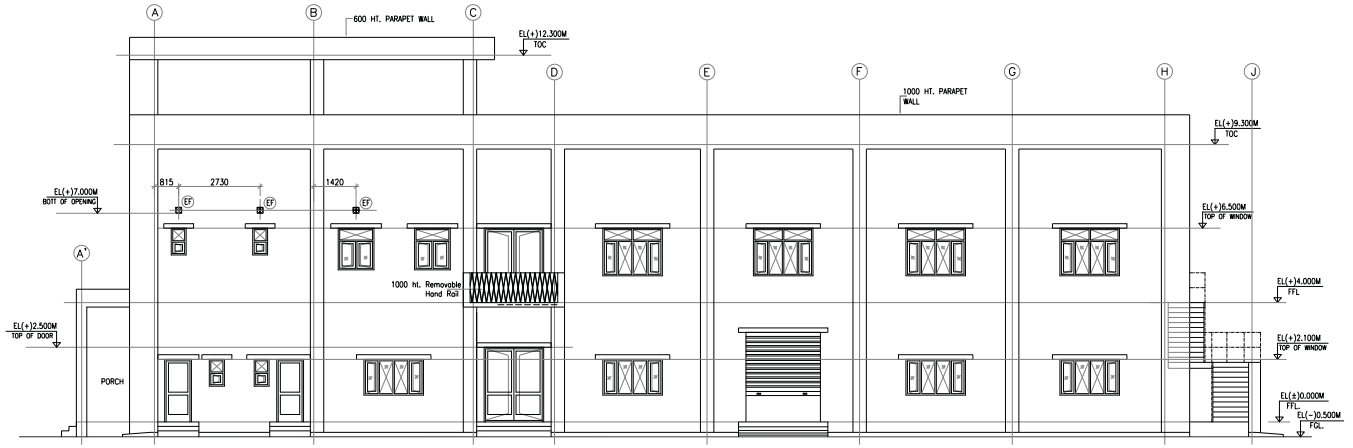
DEPT. | SCALE 1:75 | SIGN

DRAWING NO. BHEL TB-1-387-607-652

SHEET 01 OF 02 REV. 01



ELEVATION – 4



ELEVATION – 3

NOTES:-

1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
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5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]
5X800 MW YADADRI THERMAL POWER STATION

CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

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TITLE
ARCHITECTURAL ELEVATIONS OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE
R1	07.07.20	ALTERED TKR / CHECKED DKU / APPROVED PLK	

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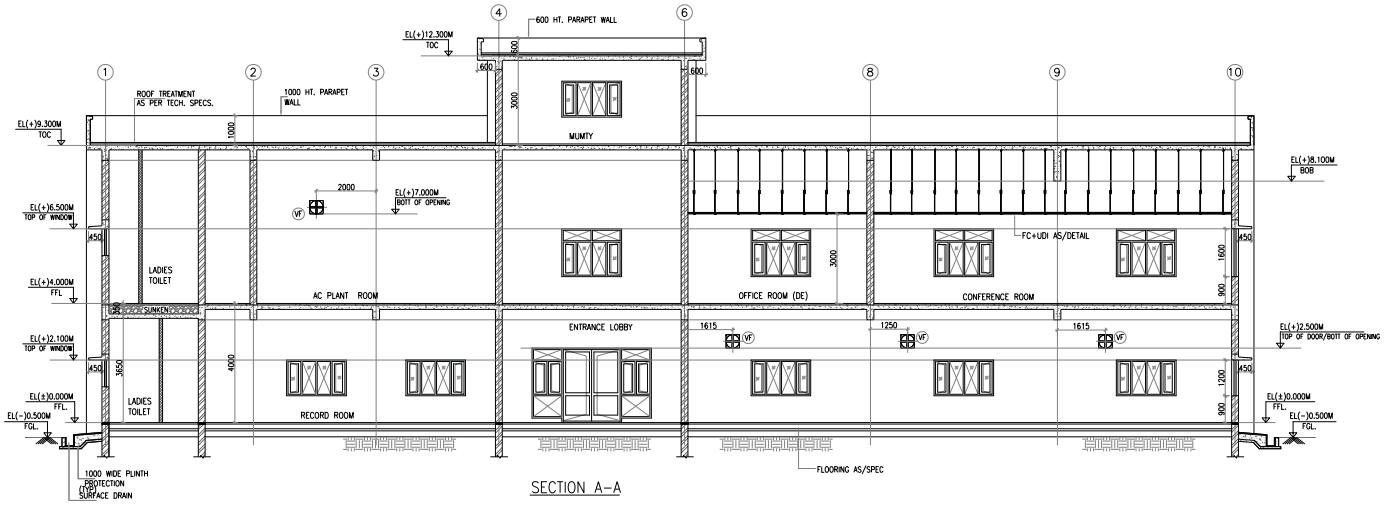
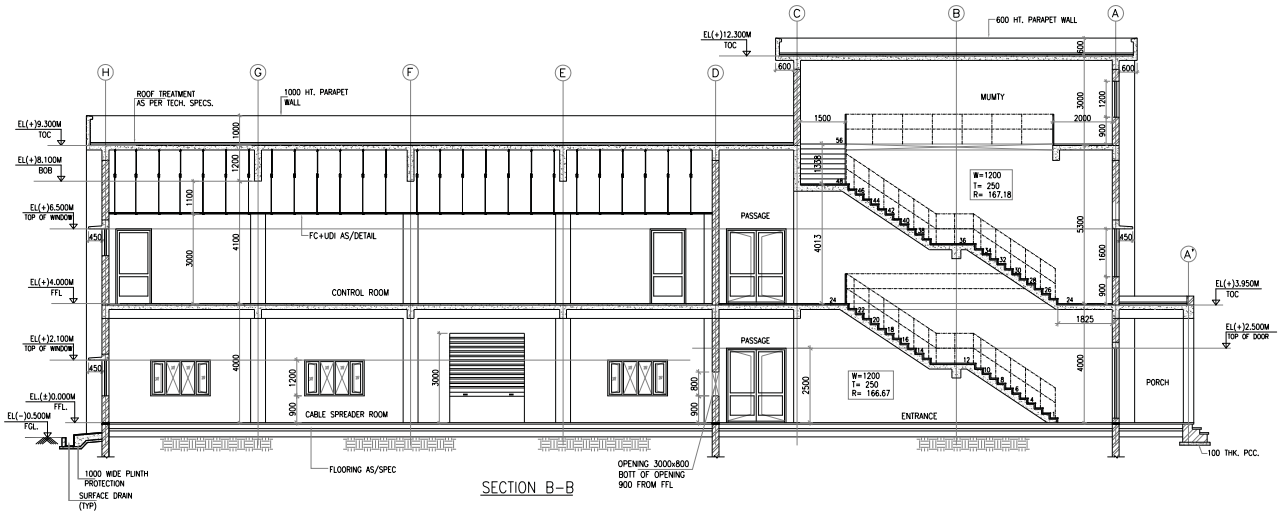
DEPT. | SCALE 1:75 | SIGN

DRAWING NO. BHEL TB-1-387-607-652

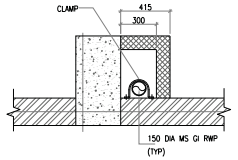
SHEET 02 OF 02 | REV. 01



SECTION A-A



SECTION B-B



TYP. RWP FIXING DETAIL

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
3. ALL DOOR-WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.
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5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]
5X800 MW YADADRI THERMAL POWER STATION

CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION PROJECTS DIVISION

ADDITIONAL INFORMATION W.O.No. 85004

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	APPD	PLK	-	04.03.20

TITLE: ARCHITECTURAL SECTIONS OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

DEPT. | SCALE 1:75 | SIGN

DRAWING NO. BHEL TB-1-387-607-653

SHEET 01 OF 01 | REV. 01

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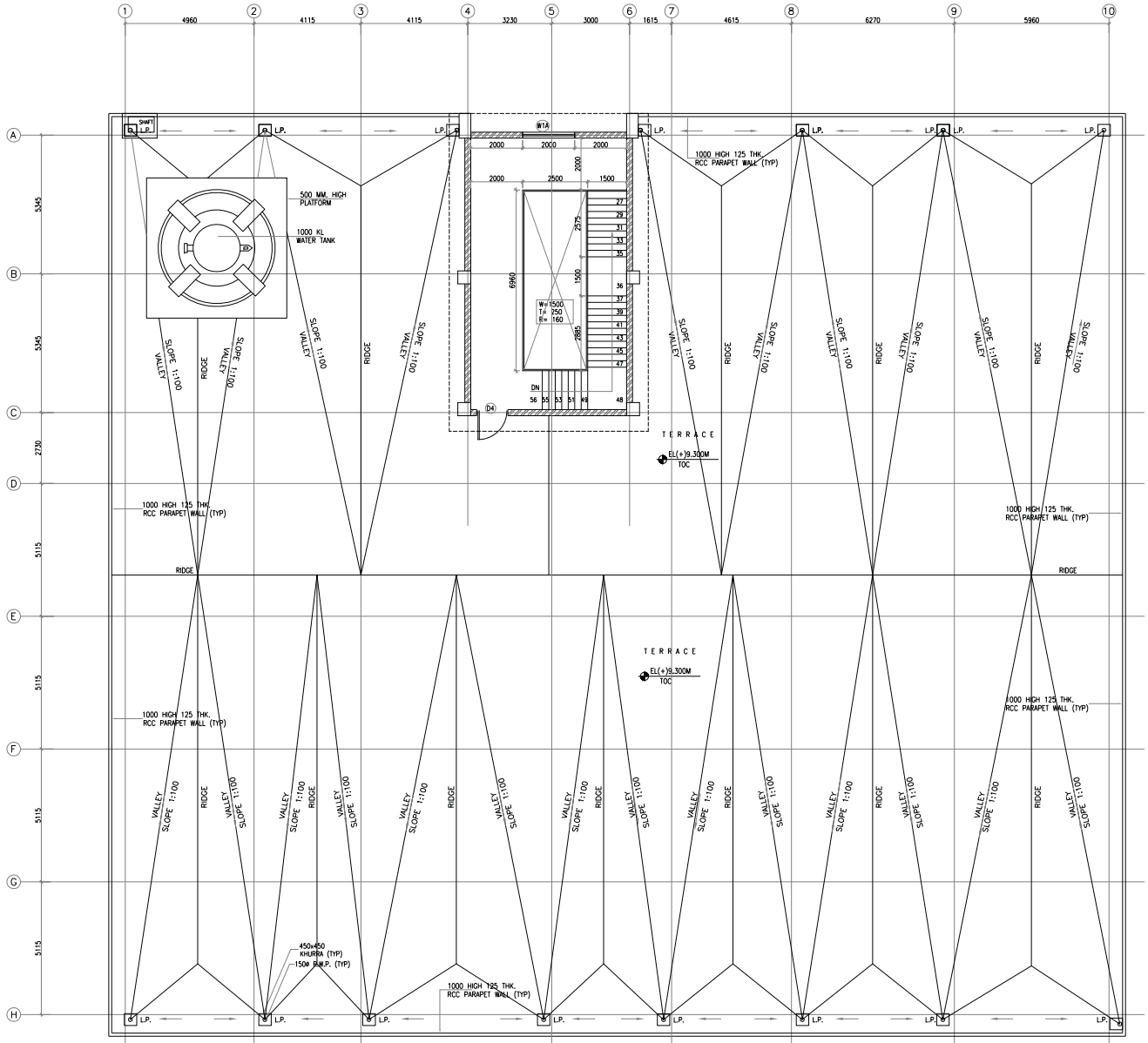

TERRACE PLAN

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. ALL WINDOWS AND VENTILATORS ON GROUND FLOOR OF ALL BUILDINGS SHALL BE PROVIDED WITH SUITABLE MS GRILL.
3. ALL DOOR-WINDOW, ETC. HEIGHT SHALL BE CONSIDERED FROM FINISH FLOOR LEVEL.
4. EEL(±)0.00M SHALL BE READ AS GROUND FLOOR FINISHED LEVEL OF SWITCHYARD CRB.
5. FINAL LOCATION OF CABLE TRENCHES REFER APPROVED ELECTRICAL DRAWINGS.
6. SIZE OF EXHAUST FAN & VENTILATION FAN SHALL BE PROVIDED LATTER.

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]
5X800 MW YADADRI THERMAL POWER STATION

CONSULTANT: TATA CONSULTING ENGINEERS LTD,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION PROJECTS DIVISION

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	CHD	DKU	-	04.03.20
	APPD	PLK	-	04.03.20

TITLE
ARCHITECTURAL TERRACE PLAN OF 400 KV SWITCHYARD CONTROL ROOM BUILDING

DRAWING NO. BHEL TB-1-387-607-654

SCALE 1:75 | DEPT. | SIGN | SHEET 01 OF 01 | REV. 01

REV.	DATE	ALTERED / CHECKED / APPROVED	REMARKS
R1	07.07.20	TKR / DKU / PLK	REVISED AS PER COMMENTS

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 dispatch 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

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 main package
4. Un priced format for mandatory spare
5. Deviation schedule /No deviation certificate in attached format 'Deviation sheet (Cost of withdrawal)'.
6. Pre bid clarification schedule

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.

PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

The bidder hereby clarifies that above mentioned are the only clarifications required on the technical specification for the subject package.

Signature: _____

Name: _____

Designation: _____

Company: _____

Date: _____

Company Seal

DEVIATION SHEET (COST OF WITHDRAWAL)

DEVIATION SHEET (COST OF WITHDRAWL)

PROJECT:- 5X800 MW YADADRI TPS

PACKAGE:- HVAC SYSTEM

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF WITHDRAWL OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRAWL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	**DESIGNATIONS**	**SIGN & DATE**	

NOTES:

1. For self manufactured items of bidder, cost of withdrawl of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. For directly dispatchable items, cost of withdrawl of deviation will be applicable on the basic price including taxes, duties & freight.
3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawl of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
6. Bidder shall furnish price copy of above format along with price bid.
7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
9. For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawl of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawl of deviation shall be taken as NIL.
10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
11. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
12. Cost of withdrawl is to be given seperately for each deviation. In no event bidder should club cost of withdrawl of more than one deviation else cost of withdrawl of such deviations which have been clubbed together shall be considered as NIL.
13. In case nature of cost of withdrawl (positive/negative) is not specified it shall be assumed as positive.
14. In case of descrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

GUARANTED AUXILIARY POWER CONSUMPTION
(FOR MAIN PLANT PACKAGE EXCEPT FOR SWITCHYARD AREA)
ANNEXURE- 1

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	TOTAL KW
		WORKING	STANDBY		
1	2	3A	3B	4	5=3Ax4
1	**AC PLANT FOR MAIN CONTROL ROOM AREAS PH-Unit # 1 & 2 (AC Plant - 1)**				
1.1	Screw Chiller	1	1		
1.2	AHU's fans for Main control room located at 24Mtr	4	2		
1.3	Fresh air fans for above AHU room.	1	0		
1.4	AHU's fans for UPS room located at 32.5Mtr	2	2		
1.5	Fresh air fans for above AHU room.	1	0		
1.6	Chilled water pumps	1	1		
1.7	Condenser water pumps	1	1		
1.8	Cooling Tower located at 32.5Mtr.	1	1		
1.9	Water Softening Plant	1	1		
1.10	Cassette AC's for battery charger room	6	6		
2	**AC PLANT FOR MAIN CONTROL ROOM AREAS PH-Unit # 3 & 4 (AC Plant - 2)**				
2.1	Screw Chiller	1	1		
2.2	AHU's fans for Main control room located at 24Mtr	4	2		
2.3	Fresh air fans for above AHU room.	1	0		

2.4	AHU's for UPS room located at 32.5Mtr	2	2		
2.5	Fresh air fans for above AHU room.	1	0		
2.6	Chilled water pumps	1	1		
2.7	Condenser water pumps	1	1		
2.8	Cooling Tower located at 32.5Mtr.	1	1		
2.9	Water Softening Plant	1	1		
2.10	Cassette AC's for battery charger room	6	6		
3	**AC PLANT FOR MAIN CONTROL ROOM AREAS PH Unit # 5 (AC Plant -3)**				
3.1	Screw Chiller	1	1		
3.2	AHU's fans for Main control room located at 24Mtr	4	2		
3.3	Fresh air fans for above AHU room.	1	0		
3.6	Chilled water pumps	1	1		
3.7	Condenser water pumps	1	1		
3.8	Cooling Tower located at 32.5Mtr.	1	1		
3.9	Water Softening Plant	1	1		
3.10	Cassette AC's for battery charger room	3	3		
4	**SERVICE BUILDING, Stage # 1 (AC Plant -4)**				
4.1	Screw Chiller	1	1		
4.2	AHU for Service Building	10	0		
4.3	Fresh air fans for above AHU room.	5	0		
4.4	Chilled water pumps	1	1		
4.5	Condenser water pumps	1	1		
4.6	Cooling Tower located at Roof	1	1		
4.7	Water Softening Plant	1	1		
5	**SERVICE BUILDING, Stage # 2 (AC Plant -5)**				
5.1	Screw Chiller	1	1		

5.2	AHU for Service Building	10	0		
5.3	Fresh air fans for above AHU room.	5	0		
5.4	Chilled water pumps	1	1		
5.5	Condenser water pumps	1	1		
5.6	Cooling Tower located at Roof	1	1		
5.7	Water Softening Plant	1	1		
6	**ESP Control Room, Unit # 1 (AC PLANT-6)**				
6.1	Water Cooled Precision AC for ESP Control Room	2	1		
6.2	Fresh air fans for above PAC room.	1	0		
6.3	Condenser water pumps	1	1		
6.4	Cooling Tower located at Roof	1	1		
6.5	Water Softening Plant	1	1		
7	**ESP Control Room, Unit # 2 (AC PLANT-7)**				
7.1	Water Cooled Precision AC for ESP Control Room	2	1		
7.2	Fresh air fans for above PAC room.	1	0		
7.3	Condenser water pumps	1	1		
7.4	Cooling Tower located at Roof	1	1		
7.5	Water Softening Plant	1	1		
8	**ESP Control Room, Unit # 3 (AC PLANT-8)**				
8.1	Water Cooled Precision AC for ESP Control Room	2	1		
8.2	Fresh air fans for above PAC room.	1	0		
8.3	Condenser water pumps	1	1		
8.4	Cooling Tower located at Roof	1	1		
8.5	Water Softening Plant	1	1		
9	**ESP Control Room, Unit # 4 (AC PLANT-9)**				

9.1	Water Cooled Precision AC for ESP Control Room	2	1		
9.2	Fresh air fans for above PAC room.	1	0		
9.3	Condenser water pumps	1	1		
9.4	Cooling Tower located at Roof	1	1		
9.5	Water Softening Plant	1	1		
10	**ESP Control Room, Unit # 5 (AC PLANT-10)**				
10.1	Water Cooled Precision AC for ESP Control Room	2	1		
10.2	Fresh air fans for above PAC room.	1	0		
10.3	Condenser water pumps	1	1		
10.4	Cooling Tower located at Roof	1	1		
10.5	Water Softening Plant	1	1		
11	**FGD Control room (Stage #1)**				
11.1	Water Cooled Precision AC for FGD Control room	3	2		
11.2	Fresh air fans for above PAC room.	1	0		
11.3	Condenser water pumps	1	1		
11.4	Cooling Tower located at Roof	1	1		
11.5	Water Softening Plant	1	1		
12	**FGD Control room (Stage #2)**				
12.1	Water Cooled Precision AC for FGD Control room	3	2		
12.2	Fresh air fans for above PAC room.	1	0		
12.3	Condenser water pumps	1	1		
12.4	Cooling Tower located at Roof	1	1		
12.5	Water Softening Plant	1	1		
13	**DM Plant Control room**				
13.1	Water Cooled Precision AC for DM Plant Control Room Building	2	1		
13.2	Fresh air fans for above PAC	1	0		

	room.				
13.3	Condenser water pumps	1	1		
13.4	Cooling Tower located at Roof	1	1		
13.5	Water Softening Plant	1	1		
				TOTAL (KW)	

Notes	
1	Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as **2075 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 2,00,000/- per KW** of additional power over EPC.
2	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 2,00,000/- per KW** shall be levied on vendor.
3	Bidder to note that Duty factor of “**1.0**” has to be considered.
4	Bidders to note that the aux. power shall be quoted in resp. formats. Further, technical loading during bid evaluation for additional power over GPC shall be calculated separately for Complete Plant (excluding Switchyard) and Switchyard Area.

GUARANTEE AUXILIARY POWER CONSUMPTION
(FOR SWITCHYARD AREA)
ANNEXURE- 2

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	TOTAL KW
		WORKING	STANDBY		
1	2	3A	3B	4	5=3Ax4
1	Air cooled, Precision Package AC units for switchyard building	2	1		
2	Cassette AC's	7	0		
				TOTAL (KW)	

Notes	
1	Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as **135 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 2,00,000/- per KW** of additional power over EPC.
2	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 2,00,000/- per KW** shall be levied on vendor.
3	Bidder to note that Duty factor of "**1.0**" has to be considered.
4	Bidders to note that the aux. power shall be quoted in resp. formats. Further, technical loading during bid evaluation for additional power over GPC shall be calculated separately for Complete Plant (Excluding Switchyard) and Switchyard Area.

SECTION-III

SUB-SECTION-7

INPUT DRAWINGS (MECHANICAL LAYOUT DRAWINGS SHOWING LOCATION OF EQUIPMENT/PLOT PLAN/OTHER BUILDING GA'S)