

**UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM
LIMITED**

1 X 660 MW PANKI TPS EXTENSION PROJECT

**TECHNICAL SPECIFICATION
FOR
HYDROGEN GENERATION PLANT**

SPECIFICATION NO: PE-TS-426-168-A001



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA**



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

REV. NO. 00

CONTENTS

SECTION	DESCRIPTION	PAGE NO.
	PROJECT INFORMATION	2-9
SECTION – I	SPECIFIC TECHNICAL REQUIREMENTS	10
SECTION – IA	SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)	11-21
	➤ ANNEXURE I: QUALITY PLAN	22-46
	➤ ANNEXURE II: SUB VENDORS LIST	47-58
	➤ ANNEXURE III: FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES	59-60
	➤ ANNEXURE IV: DRAWING DOCUMENTS DISTRIBUTION PROCEDURE	61-65
	➤ ANNEXURE V: PAINTING SPECIFICATION	66-81
	➤ ANNEXURE VI: MANDATORY SPARES LIST	82-88
	➤ ANNEXURE VII: DRAWING/DOCUMENTS SUBMISSION SCHEDULE	89-92
	➤ ANNEXURE VIII: DM AND COOLING WATER ANALYSIS	93-94
	➤ ANNEXURE IX: LIST OF TOOLS & TACKLES (AS APPLICABLE)	95
	➤ ANNEXURE X: FORMAT FOR OPERATION AND MAINTENANCE MANUAL	96-99
	➤ ANNEXURE XI: SITE STORAGE AND PRESERVATION	100-109
	➤ ANNEXURE XIII -GUARANTEED PERFORMANCE DATA	110-111
	➤ P&ID AND EQUIPMENT LAYOUT	112-118
SECTION – IB	SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)	119
	➤ ELECTRICAL EQUIPMENT SPECIFICATION	120-121
	➤ ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR	122-125
	➤ ELECTRICAL LOAD DATA FORMAT	126-127
	➤ CABLE SCHEDULE FORMAT	128-129
SECTION – IC	SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)	130-139
SECTION – II	GENERAL TECHNICAL REQUIREMENT	140
SECTION – IIA	GENERAL TECHNICAL REQUIREMENT (MECHANICAL)	141-236
SECTION – IIB	GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)	237-262
SECTION – IIC	GENERAL TECHNICAL REQUIREMENT (CONTROL AND INSTRUMENTATION)	263-427
SECTION - III	➤ SCHEDULE OF PRE BID CLARIFICATIONS	428-429
	➤ COMPLIANCE CUM CONFIRMATION SCHEDULE	430
	➤ SCHEDULE OF DECLARATION	431
	➤ SCHEDULE OF DEVIATIONS	432



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SUB-SECTION:

REV. NO. 00

PROJECT INFORMATION

CHAPTER 2 : GENERAL PROJECT INFORMATION

1.0 PROJECT INFORMATION

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

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

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

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

S. No.	Description	Unit	Parameter
	Hydroxyl	ppm as CaCO ₃	0.05
	Chlorides	ppm as CaCO ₃	20
	Sulphate	ppm as CaCO ₃	36
	Nitrate	ppm as CaCO ₃	0.5
	Total Anions	ppm as CaCO ₃	157.5
4	Carbon Di-oxide as CO ₂	ppm	1.97
5	Dissolved Silica	ppm as SiO ₂	10.0
6	Colloidal Silica	ppm as SiO ₂	0.5
7	Organic Matter	ppm as O ₂	4.0

Appendix – II : Coal Quality Parameter

Sl.N o.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
1.0.	Proximate Analysis (As Received Basis)	By Weight			
1.1.	Moisture	%	10.5	12	12
1.2.	Ash	%	35	43	32
1.3.	Volatile Matter	%	26	19	27
1.4.	Fixed Carbon	%	28.5	26	29
1.5.	Total	%	100	100	100
1.6.	Gross Calorific Value	kcal/kg	3700	3200	4200
2.0.	Ultimate Analysis (As Received Basis)				
2.1.	Moisture	%	10.5	12	12
2.2.	Ash	%	35	43	32
2.3.	Carbon	%	42	33.5	44
2.4.	Hydrogen	%	2.0	2.4	2.77
2.5.	Nitrogen	%	1.6	1.3	1.5
2.6.	Sulfur	%	0.46	0.45	0.5
2.7.	Oxygen	%	8.44	7.35	7.23
2.8.	Total	%	100	100	100
3.0.	Hard Groove Index		53	50	55
4.0.	Ash Fusion Range				
a)	Initial Deformation Temperature	⁰ C	1200	1154	1165
b)	Hemispherical Temperature	⁰ C	1350	1300	>1350

Sl.No.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
c)	Fusion Temperature	°C	>1400	>1400	>1400

Source: Saharpur Jamarpani Coal Mine, Jharkhand
Imported Coal

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

Source: Indonesia / South African coal

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

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

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

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

2.0 Access to Site

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

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

3.0 Plant Rating, Capacity, Availability, PLF

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

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

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

4.0 Power Evacuation

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

जलवायवी सारणी CLIMATOLOGICAL TABLE

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

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

अक्षांश: 26°28' N LONG: 80°22' E
HEIGHT ABOVE M.S.L.: 120 METRES

रेखांश: 80°22' E

समुद्री सतह से ऊंचाई
HEIGHT ABOVE M.S.L.

मीटर
METRES

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

वायु तापमान										आर्द्रता		मेघ की मात्रा		वर्षा	
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
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मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य		वर्षा			
मध्य		दैनिक		रात्रि से पूर्व से		दैनिक		रात्रि से पूर्व से		संवेद्य					



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION:

REV. NO. 00

SPECIFIC TECHNICAL REQUIREMENTS



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
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SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

SUB-SECTION – IA

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)



TITLE : 1X660 MW PANKI TPS EXTN.	SPECIFICATION NO. PE-TS-426-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	REV. NO. 00	

1.0 INTENT OF SPECIFICATION

- 1.1 The intent of specification is to cover design (i.e. Preparation and submission of drawing/ documents including " As Built " drawings and O&M Manuals) , engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables , mandatory spares along with spares for erection ,startup and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in site transportation, assembly, minor civil works, erection & commissioning, trial run at site and carrying out performance guarantee /Functional / Demonstration tests at site , obtaining CCOE approval & final handing over to end customer in flawless condition for project and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.
- 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 of **HYDROGEN GENERATION PLANT**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to 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 terms 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 section-III of the specification. 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.



TITLE : 1X660 MW PANKI TPS EXTN.	SPECIFICATION NO. PE-TS-426-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	REV. NO. 00

- 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 section – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – IA shall prevail over section – IIA and Section-IB & IC shall prevail over Section-IIB & IIC, however more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser / Employer, consultant, please referred relevant clause(s) of GCC.
- 1.12 “Note 1:- Bidder to note that the building along with foundation of equipment has already been constructed at site. Bidder to accommodate their equipment within the foundation already constructed. Any modification required in foundation to accommodate bidder's equipment shall be part of bidder's scope. Bidder is advised to visit site for clarity of actual site condition w.r.t Hydrogen generation plant civil works before bid submission. Further, equipment layout with foundation details of Hydrogen Generation Plant (BHEL Dwg. No. PE-V0-426-168-A001) is enclosed with this specification & bidder to follow the same”.
- 1.13 “Note 2: - Bidder to note that MCC for Hydrogen Generation Plant is already available at the site. Further, Bidder to note that the Final Electrical Load of all the drives are mentioned in sub-section- IB and the same shall be adhered to by the Bidder. In case any modification is required in MCC due to change of Load data, the same shall be in bidder's scope.
- 1.14 “Note 3: - Bidder to note that PLC for Hydrogen Generation Plant has already manufactured and dispatched to site. Further, Bidder to note that the same shall be free issued to successful bidder. In case any modification is required in PLC due to manufacturer's design, the same shall be in bidder's scope.
- 1.15 “Note 4: - Bidder to note that Hydrogen Generation Skids (2nos.) has already manufactured and dispatched to site. Further, Bidder to note that the same shall be free issued to successful bidder. In case any modification is required in Hydrogen Generation Skids due to manufacturer's design, the same shall be in bidder's scope. Bidder is advised to visit site for clarity of actual site condition w.r.t Hydrogen generation plant skids before bid submission for skids details, Dwg. No. PE-V0-426-168-A002 is enclosed here with this specification & bidder to follow the same”. Further, refurbishment / replacement of already supplied item shall also be in bidder's scope



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

1.16 Note-5 Following item already dispatched at site: -

1. Item already mounted on each skid
 - a. Electrolyser
 - b. Lye Filter
 - c. Lye Pump
 - d. O2 Seperator
 - e. H2 Seperator
 - f. O2 Moisture Gas Seperator
 - g. H2 Moisture Gas Seperator
 - h. Lye Cooler
 - i. Catalyst Column
 - j. Dry Absorber
 - k. Gas Condenser
 - l. Water Gas Seperator
 - m. Gas Cooler
 - n. DM Water cum Lye Making Tank
 - o. H2 Buffer Tank
 - p. O2 Demister
 - q. H2 Demister
 - r. N2 Manifold.
 - s. Inline Gas Filter
 - t. DM Water feed Pump
2. 2 Nos. Rectifier.
3. PLC Panel Including PLC Software Hardware.
4. H2 Manifold.

2.0 SCOPE OF SUPPLY:

Note1:- Bidder to note that the technical specification is prepared considering Unipolar and bipolar design. So the equipment and mandatory spares as applicable for Unipolar and bipolar design as per manufacturer standard practice shall be supplied.

A) Scope of Supply by Bidder: - (Strike off item already supplied to site. However, any other item required for completeness of plant and safe operation is also in scope of bidder.)

- ~~2.1 Two streams of electrolyzers working in parallel (each of capacity minimum 10 Nm³/hr.).~~
- 2.2 Three (3) numbers of hydrogen gas compressors and drives (each of minimum 12.5 Nm³/hr.). Each compressor set shall be capable of compressing hydrogen gas from suction pressure corresponding to that of the low pressure at generation point to the pressure required to fill the hydrogen cylinders i.e. 150 Kg/cm² (gauge), with pressure gauge, safety relief valve, temperature gauge etc. along with flame proof electric motor, cell purging system, hydrogen gas buffer tanks.
- ~~2.3 Two (2) nos. Dual Type After Filters to prevent entrainment of desiccant particles with the effluent gas from the dryer unit.~~
- ~~2.4 One (1) no. Gas Washing Tank per stream or any other alternative device to remove traces of caustic potash entrained with hydrogen gas. Each gas washer has level transmitters.~~



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

- 2.5 Two (2) nos. Portable Hydrogen Gas Purity Meters. These meters shall be battery operated.
- ~~2.6 Two (2) nos. Hydrogen filling stations with manifold isolating valve, safety valve etc. for both evacuation and simultaneous filling of minimum 4 cylinders (total 8 nos.) shall be provided with hydrogen at a maximum filling pressure of 150 Kg/cm² (gauge). Each filling manifold shall be provided with a common vacuum pump for evacuation of air from hydrogen cylinder prior to filling.~~
- ~~2.7 Two (2) nos. Nitrogen manifold common for both streams shall be provided. Each nitrogen manifold shall comprise of two 2 nos. for complete purging of the hydrogen gas streams, along with complete scavenging system comprising necessary piping network, all fittings, pressure reducing station etc.~~
- 2.8 One numbers DM Water Storage Tank of net capacity adequate enough for 5 days' normal requirement of hydrogen gas generation on continuous basis at rated capacity of the Hydrogen Generation Plant. Tank will be fitted with drain connections, level transmitters, level indications. The Tank shall be of HDPE construction. Water level shall be controlled via a solenoid valve with float type level switch assembly mounted at tank top.
- ~~2.9 De-oxy units, coolers, hydrogen gas purification system, filling manifold, piping fitting, valves, complete with required instrumentation and other items as per P&ID for the hydrogen generation plant enclosed with this technical specification.~~
- 2.10 Bidder shall include vacuum pump and high-pressure cylinder testing apparatus along with all accessories for testing cylinders.
- 2.11 Bidder to include the Ventilation Requirement for hazardous and non-hazardous area including toilets and MCC room in his scope for the H₂ Plant building as per the requirement specified in the technical specification.
- 2.12 Bidder shall also include in his scope window Air-conditioners for his control panels etc. Bidder to specify the same in his offer.
- 2.13 Chiller unit consist of two nos. (1W+1Sb) air cooled chillers, one number Chiller water storage tank of adequate capacity, two nos. chilled water re-circulation pumps complete with drive motors along with strainers and all other necessary instruments, isolation valves, piping, flanges, pipe fittings etc.
- 2.14 2X100% capacity air compressors and 2X100% capacity air drying plant to meet the requirement of hydrogen generation plant. The compressors shall be oil free. However, in case of oil lubricated compressors, the air shall contain less than 0.1 ppm of oil and bidder shall supply 6 numbers filter cartridge as a spare. The compressor shall be for continuous duty and the air quality shall be suitable for instrumentation.
- 2.15 Suitable number of Hydrogen Leak Detectors along with sensors shall be in scope of bidder.
- 2.16 Four (4) nos. Nitrogen Cylinders along with accessories.
- 2.17 Eight (8) nos. Hydrogen Cylinders along with accessories.
- 2.18 Required number of Flame arrestors (min) two number shall be in bidder's scope.
- 2.19 Required number of Gas filters shall be in bidder's scope.
- 2.20 2X100% Battery chargers along with batteries and other accessories shall be in scope of bidder.
- 2.21 Bidder to note that Battery chargers has already been supplied. However, ACDB, Batteries along with other accessories is in bidders' scope.
- 2.22 Bidder to note that PLC has already been supplied. However, back up panel, furniture, OWS, laptop etc. with other accessories is in bidders' scope. (Refer PLC scheme enclosed with the specification).
- 2.23 Bidder shall include in his scope necessary support/platform /ladder/hanger /anchor bolts as required for satisfactory erection / commissioning & operation of plant shall be provided by bidder.
- 2.24 Bidder shall include in his scope all hydrogen generation plant pipes and conduit support. All drains shall be terminated at point in hydrogen generation plant building.
- 2.25 Bidder shall also provide connection, isolation device, manifold, piping etc. for N₂ gas connection to cell system for purging.
- 2.26 Bidder to note that N₂ gas required for purging the system during commissioning/Demonstration test/trial operation etc. till handing over the plant to shall be arranged by bidder.
- 2.27 Bidder shall include in his scope one lot of mandatory spares as per list enclosed as ANNEXURE VI of technical specification.
- 2.28 Bidder shall also obtain the necessary clearances etc. from Govt. Agencies for the Hydrogen Generation plant. Hydrogen generation and storage system shall comply with all applicable federal state laws, and local ordinances.



TITLE : 1X660 MW PANKI TPS EXTN.	SPECIFICATION NO. PE-TS-426-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	REV. NO. 00

- 2.29 Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements for successful running of hydrogen Generation plant.
- 2.30 Start-up & Commissioning spares.
- 2.31 Mandatory spares.
- 2.32 Counter flanges, blank flanges, isolation valves at all the terminal points as required as per system requirements.
- 2.33 All special tools necessary for proper maintenance or adjustment of the equipment packed in permanent box.
- 2.34 All necessary structural steel for pipe supporting structure, platforms, walkways / pathways and access stairs, mechanical plant and equipment, mechanical services and pipe work associated with Hydrogen Generation Plant.
- 2.35 Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc. as required to grout in civil works and to support/hold the equipment being supplied under this specification for opening/maintenance purpose.
- 2.36 All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles.
- 2.37 Wrapping, coating and protection of all the buried pipe shall be as per IS 10221 or AWWA C 203.
- 2.38 Finish paint for touch-up painting of equipment after erection at site in sealed containers.
- 2.39 Set of special tools and tackles if required for maintenance and erection of equipment supplied.
- 2.40 All necessary flanges and counter flanges to interconnect the piping.
- 2.41 All insert plates, puddle pipes, nuts and bolts, counter flanges, grouting material wherever applicable shall be in the scope of bidder.
- 2.42 Embedment plates with lugs shall also be provided by bidder as per system requirement.
- 2.43 Monitoring gadgets, instruments and equipment required for commissioning & maintenance (till PG test and plant handover).
- 2.44 Instrument hook up material shall be in bidder's scope.
- 2.45 MOC of pipes carrying H2 gas shall be SS 316.

3.0 SCOPE OF SERVICE:

The bidder's scope also includes the following services at site:

- i) Design and engineering of entire hydrogen generation Plant
- ii) Erection and commissioning, unloading, storage and handling at site.
- iii) Arrangement of all instruments and lab facilities to carry out trial run, commissioning and PG test.
- iv) Minor Civil work including chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself etc. To the extent possible, vendor shall ensure to supply all foundation bolts timely so as to facilitate placement of these bolts while casting the foundation. Wrapping, coating and protection of all the buried pipe shall be as per IS 10221.
- v) In site transportation.
- vi) Pre- Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.
- vii) Monitoring gadgets, instruments and equipment required for maintenance (till PG test and plant handed over).
- viii) All personal required during commissioning and PG test.
- ix) Complete grouting for equipment including grouting material, fixing and any concreting inside the plant.
- x) Trial run for requisite period.
- xi) Performance testing.
- xii) Painting as per enclosed painting schedule. However, any variation in the painting schedule as finally approved by customer shall be taken care by the bidder without any commercial and delivery implication. Colour coding scheme shall be intimated to vendor during detailed engineering.
- xiii) Final touch up painting at site.
- xiv) Obtaining CCE approval.
- xv) Preparation of civil assignment drawings i.e. pedestals details; insert plates / embedment's plates



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

required for supporting pipes and equipment etc. and review of civil drawing prepared by BHEL based on civil assignment drawing of bidder. In case any modification is required in the civil work already done based on civil inputs given by vendor, rework shall be done at the cost and risk of the vendor.

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

4.0 TERMINAL POINTS:

TP1:- DM water (Refer annexure – VIII, section-IA, for cooling water analysis) shall be used as cooling water and shall be terminated at a distance of 10m from the hydrogen plant building at ambient temperature and pressure of 4 kg/cm² (min) and the same may be used as cooling water. Bidder to include in his scope all the equipment and accessories required for closed loop cooling with chiller unit for cooling of equipment. Chiller unit consist of two nos. Air cooled chillers, one number Chiller water storage tank of adequate capacity, two nos. chilled water re circulation pumps complete with drive motors along with strainers and all other necessary instruments, isolation valves, piping, flanges, pipe fittings etc.

TP2, Feed water (Refer annexure – VIII, section-IA, for the feed water analysis): - Bidder to note that the DM quality feed water shall be terminated at one point (10 meter from hydrogen generation plant building) for hydrogen generation. Further distribution of DM feed water shall be in bidder's scope.

Note: - Temperature of feed water / cooling water at TP1 shall be as per ambient conditions.

TP3:- Bidder to note that no Instrument and service air shall be provided Bidder to note that the instrument air / service air shall not be provided by customer. If instrument / service air is required by bidder for any of his equipment, bidder shall include 2X100% capacity air compressors and 2X100% capacity air drying plant to meet the requirement of hydrogen generation plant. The compressors shall be oil free. However, in case of oil lubricated compressors, the air shall contain less than 0.1 ppm of oil and bidder shall supply 6 numbers filter cartridge as a spare. The compressor shall be for continuous duty and the air quality shall be suitable for instrumentation.

TP4, Drains: - All drains shall be terminated at one point by bidder.

5.0 SCOPE OF SUPPLY (ELECTRICAL)

Complete electrical as per specification / details indicated in Section IB (Specific Technical Requirement Electrical) and IIB (General Technical Requirement Electrical).

6.0 SCOPE OF SUPPLY (C&I)

Complete C&I as per specification / details indicated in Section IC (Specific Technical Requirement C&I) and IIC (General Technical Requirement C&I).

7.0 SCOPE OF SUPPLY (CIVIL)

- 7.1 Total Civil construction work at site is in BHEL's Scope of work, however complete grouting for equipment, pumps, blowers etc. fixing of equipment, pumps, blowers etc. as required shall be in bidder's scope.
- 7.2 Pedestals for pipe supports, however, auxiliary structure, supports components for piping is in bidder's scope.
- 7.3 Also detailed Civil Input drawing shall be provided by bidder. Successful bidder shall furnish civil assignment drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the successful bidder for concurrence

8.0 BIDDER TO FURNISH FOLLOWING DOCUMENT/INFORMATION ALONG WITH THE BID.

- 8.1 Pre-bid if any in enclosed pre-bid schedule.
- 8.2 Deviation schedule duly fill for deviation along with cost of withdrawal, if any.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

- 8.3 Schedule of Declaration.
8.4 Guaranteed Performance Data.

9.0 EXCLUSIONS

- a) Service water and potable water up to the terminal point.
b) All civil construction Works at site.

10.0 QP AND SUB VENDOR APPROVAL

Bidder to note the QP requirement shall be in line with the Annexure-I of technical specification. However, detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be decided during detailed engineering. All inspection & testing etc. shall be carried out accordingly. Any changes/additional tests insisted upon by Owner during detailed engineering shall be accepted by bidder without any commercial implication to BHEL/Owner.

11.0 SUB VENDOR

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

12.0 DESIGN/CONSTRUCTION

- The P&IDs (Dwg.No.-PE-DG-426-168-A001) is enclosed herein in this section for bidder's compliance.
- The material of construction specified in specification are minimum requirements and material of construction for other components not specified shall be similarly selected by the bidder for intended duty which shall be subjects to customer approval during detailed engineering without any delivery and price implication to BHEL.
- The technical specification requirement for items which are not included shall be subject to customer/BHEL approval during detailed engineering stage. Vendor will submit all the backup documents for provenances of the technical details selected.

13.0 DRAWING/DOCUMENTS REQUIREMENT

For the Drawings/Documents submission schedule, please refer ANNEXURE-VII.

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

14.0 SPARES

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

15.0 MANDATORY SPARES

- a. The list of mandatory spares which is to be considered by bidder in their scope are indicated in Annexure VI.
- b. All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipment.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

- c. Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.
- d. Inspection of mandatory spares shall be in line with the approved quality plans for the respective items/equipment. The inspection categorization of mandatory spares shall also be in line with the approved Categorization plan for the respective items/equipment.

16.0 START-UP & COMMISSIONING SPARES

- a. Start-up and commissioning spares are those spares which are required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the BHEL/Customer shall come under this category. The Bidder shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipment are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Bidder.
- b. The Bidder shall indicate the service expectancy period for the spares under normal operating conditions before replacement is necessary.
- c. All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.
- d. All the spares (mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.
- e. Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.
- f. All cases, containers or other packages are to be opened for such examination as may be considered necessary by BHEL / Customer.
- g. The Bidder will provide the BHEL/Customer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipment covered under the contract and will further ensure with his vendors that the BHEL/Customer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.
- h. The Bidder shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.
- i. The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified.

17.0 ADDITIONAL REQUIREMENT

- Any statutory requirement / clearance required for the package from government / local body shall be in bidder's scope.
- 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 shall be taken from BHEL. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while



TITLE : 1X660 MW PANKI TPS EXTN.	SPECIFICATION NO. PE-TS-426-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	REV. NO. 00

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.

- KKS numbering if required, as per BHEL/Customer requirement shall be provided by the Bidder during detailed engineering stage without any commercial/delivery implication to BHEL.
- Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- Buried piping shall be protected as under (as per IS-10221).
 - Surface cleaning by wire brush, power tool cleaning etc.
 - Apply one coat of coaltar/primer/enamel.
 - Apply one layer of tape comprising of coaltar. Application of tape shall conform to AWWA C-203/IS 10221 (appendix-B) with Minimum thickness of tape as 4MM +10%
- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
- 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.
- Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.
- Preparation of drawings / document / P&ID's in 3D modelling software and providing soft copy of same to BHEL.
- Wherever local instruments for measurement of Flow, Pressure, Level is indicated in the P&ID, Bidder to provide Diaphragm seal type instrument for Chemical (all type and concentration), corrosive, viscous fluids application.
- All the vertical pumps shall be considered as self-lubricating type unless specifically mentioned.
- All piping, valves, fittings to be selected by bidder of minimum PN 10 or 150# class rating.

18.0 INSTRUCTIONS TO BIDDER

- a) The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve them of the responsibility of providing such facilities to complete the supply, erection and commissioning of Complete Pretreatment Plant.
- b) It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance herewith.
- c) 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.
- d) The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

by this specification are subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

- e) While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **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 BHEL/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 BHEL/ Customer as and when brought to their notice either by the bidder or by BHEL/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.
- f) The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- g) Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.
- h) In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- i) Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer.
- j) The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL/Customer as per approved QAP.
- k) BHEL's/Customer's representative shall be given full access to the shop in which the equipment are being manufactured or tested and all test records shall be made available to him.
- l) Pre-bid meeting shall be held before bid submission. Bidder to ask all their queries in pre-bid meeting.



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ANNEXURES



TITLE :
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ANNEXURE-I: QUALITY PLAN

CHAPTER 11 : QUALITY ASSURANCE REQUIREMENTS**1.0 INTRODUCTION**

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

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

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

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

2.0 ENGINEERING**2.1 Prior to finalization of contract**

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

2.2 Purchaser's Participation

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

2.3 Engineering Quality Assurance and Quality Control Requirements

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

2.3.1 Design Control

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

- (a) Establish internal as well as external discipline relationships.
- (b) Qualifications of personnel assigned for each task.
- (c) Establish audit procedures to ensure that the design conforms to the requirements.
- (d) Define and outline the number of multi-discipline design reviews.
- (e) Establish procedures for handling design changes.
- (f) Establish guidelines to handle all issues in pre-award, award and pre-fabrication with Manufacturer's and Sub-contractors.

2.3.2 Document Control

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

- (a) Authorized use of documents
- (b) Receipt, logging and distribution of documents
- (c) Procedure for updating and implementation of additions and revisions.
- (d) Procedure for document transmittal to Purchaser. Some of the requirements for document transmittal may be covered in other parts of this specification.

2.3.3 Audits

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

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

2.3.4 Engineering Sub-Contractor

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

2.4 Procurement

2.4.1 Source Quality Control

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



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

2.4.2 After Award of Subcontract

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

2.4.3 Purchaser's Participation

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

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

2.4.4 Communication

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

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

2.5 QA/QC Requirements

2.5.1 Inspection Plan



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

2.5.2 Inspection Office

- 2.5.2.1 The Contractor shall identify the key inspection office located at its engineering and construction office. All inspection assignments, inspection instructions, after placement of the purchase order shall be covered from this designated office.
- 2.5.2.2 One individual in the Contractor's key inspection office shall be designated to fill the function outlined in 2.5.3 and must report to the Contractor's Manager of inspection. Additional staff may be added as necessary, provided they are under the supervision of the individual designated. This individual will hereafter be referred to as the "Quality Control Project Inspector (QCPI)".
- 2.5.2.3 For technical problems arising during manufacturing, after purchase orders are placed, the QCPI is responsible for clearing such technical problems with Engineering and/or Purchaser. All purchase orders shall have a clause requiring the Sub-Contractor to submit all questions of a technical nature concurrently to the QCPI and requisitioning Purchaser in writing through fax or letter for resolution. The QCPI shall be responsible for obtaining replies from engineering, documenting the response to the Sub-Contractor and making distribution. The assigned QCPI shall be on distribution for all other correspondence. When technical requests arise from rejection made by the Contractor's source Inspector, the source Inspector's rejection report must be attached to the Sub-Contractor's request for engineering evaluation.

2.5.3 Inspection Co-ordination and Responsibility

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

- (a) Issue assignments for source inspection.
- (b) Issue specific inspection instructions when required to the assigned source inspector.
- (c) Indicate the required type of report forms.
- (d) Coordinate and respond to questions of a technical nature.
- (e) Monitor inspection reports to determine if inspections are being performed as per written instructions.
- (f) Forward all related order correspondence to the assigned source Inspector.
- (g) Receive inspection reports from the source Inspector and make distribution as required.

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

2.5.4 Inspector's Qualifications

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

2.5.5 Inspectors responsibilities

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

- (a) Pre-fabrication meeting – the Contractor's Inspector shall conduct a pre-fabrication meeting with the Sub-contractor prior to start of fabrication. The discussion shall include, but not be limited to a review of the following items:
 - (i) Purchase order requirements with emphasis on any special requirements (technical and quality).
 - (ii) Code Requirements.
 - (iii) Sub-contractors Quality Control Programs.
 - (iv) Fabrication Schedule.
 - (v) Major Sub-contractors.
 - (vi) Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Welder Performance Records (WPR).
 - (vii) Non-Destructive Examination Requirements.
 - (viii) Testing – Hydrostatic and Pneumatic.
 - (ix) Manufacturer's Data Reports.
 - (x) Preservation, Packing and Shipping.
 - (xi) Extent of Purchaser / Contractor Inspection.
 - (xii) Witness Points and Hold Points and Notice requirements.
- (b) Initial inspection visit: The Inspector shall perform as a minimum, the following inspection activities prior to start of fabrication.
 - (i) Review fabrication schedule to ensure required Quality Control examinations and other intermediate tests have been included.
 - (ii) Establish approval of major Sub-contractors.

- (iii) Verify that Welding Procedures and Procedure Qualifications have been approved.
 - (iv) Verify that all welders assigned to job are qualified.
 - (v) Review Mill Test Reports to verify materials meet specifications.
 - (vi) Review Sub-contractor's Examination and Inspection Plan.
 - (vii) Review Sub-contractor's procedure for identifying and transferring material markings.
 - (viii) Make a visual examination of major materials, verify Sub-contractor's examination of all materials, and verify proper storage facilities (environment and security).
- (c) Progressive inspection visits: The following minimum activities, where applicable, shall be executed and reported upon by the Inspector:
- (i) Monitor on a random basis the transfer of material marking throughout the fabrication.
 - (ii) Initial and random inspection of edge preparation, root gap and fit up for all vessel and fabricated machinery components.
 - (iii) Initial and random witnessing of production welding to verify approved procedures, qualified welders and proper techniques are being used.
 - (iv) Ensure that welding materials are being properly controlled.
 - (v) Inspect major weld seams, nozzle and attachment welds, overlay welding and any weld repairs.
 - (vi) Perform random check of back gouging of pressure retaining welds.
 - (vii) Inspect critical/major materials from sub-Sub-contractors.
 - (viii) Check nozzles / man ways for size, rating and extension.
 - (ix) Check dimensions and workmanship of components.
 - (x) Examine gaskets and bolting against specifications.
 - (xi) Check location and attachment welds for support clips, lugs, brackets and saddles.
 - (xii) Make final visual inspection for quality of work and for damage.
 - (xiii) Make complete dimensional inspection.
 - (xiv) Witness all hydrostatic and pneumatic testing.
 - (xv) Witness routine and special testing as may be outlined in project specifications or data sheets for Electrical and Instrumentation chapters.

- (xvi) Assure electrical and instrument function and operational checks have been performed as per project specifications.
- (d) Non-destructive Examination (NDE) – The Inspector shall perform as a minimum, the following NDE activities during progressive inspections:-

(i) Radiographic examination (RE)

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

(ii) Ultrasonic examination (UE)

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

(iii) Magnetic particle examination (MPE)

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

(iv) Liquid penetrant examination (LPE)

- Same as for MPE

(v) Hardness testing – production welds

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

(e) Shipping

- (i) Verify that all shipping requirements related to cleaning, dry out, surface preparation.
- (ii) Verify that pressure equipment is appropriately code stamped and all "Manufacturer's Certified Data Reports" are complete and properly signed.
- (iii) Verify required documentation for acceptance and record is complete.

2.5.6 Inspection Reports

- 2.5.6.1 Inspection reports for interim inspection visits shall be consecutively numbered and identify non-conformance and exceptions found /corrected at that time. Final checklists should indicate all items inspected during interim inspections.
- 2.5.6.2 Inspection rejection reports shall be by telefax to the key office and Purchaser when the Sub-Contractor's proposed resolution deviates from order specifications, or would require repairing.

- 2.5.6.3 Final inspection reports shall be by check off for all major equipment and bulk piping components. The check off indicates the inspections were performed and would be covered on an interim inspection report.
- 2.5.6.4 Inspection release certificate shall be issued by the assigned Inspector only after all the requirements of the purchase order have been met. The Sub-contractor shall be given the inspection release certificate as authorization to present final billing to the Contractor and a copy of same shall be attached to the packing list to serve as notification to the job site of inspection approval.

2.6 Construction

2.6.1 Purchaser's Participation

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

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

2.6.2 Communication

- 2.6.2.1 Direct, informal communication between the Contractor's field Inspectors and Purchaser's auditing Inspectors is mandatory. Further Purchaser shall be advised when major problems related to design or fabrication is uncovered.
- 2.6.2.2 Contractor's in-progress inspection reports, follow up/punch out sheets, records of radiograph inspections, etc. shall be available to Purchaser's auditing Inspectors during the course of the Works.
- 2.6.2.3 At the end of the Work, Contractor's standard inspection reports, check off sheets, radiographs, master copy of loop diagrams, electrical test data sheets, etc. shall be turned over to Purchaser in an organized, agreed upon format. Contractor shall verify that all of the required documentation of the equipment has been received and placed in the equipment files. The Contractor is responsible for obtaining any outstanding documentation from the suppliers.

2.6.3 Construction QA/QC requirements

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



(a) **Quality Control Program**

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

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

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

(c) **Inspector Qualifications**

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

(d) **Document Control**

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

(e) **Receiving Control**

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

(f) **Receiving inspection**

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

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

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

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

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

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

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

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



- (a) Soil testing
- (b) Pile driving record data (if applicable)
- (c) Structural concrete
- (d) Performing random dimensional check and visual material verification of field fabricated pressure equipment and of any piping, vessel, electrical and instrumentation installation.
- (e) Internal checking of all vessels for:
 - (i) Cleanliness
 - (ii) Proper internals. This involves opening the vessel manways and removal of internals.
- (f) Witness testing and installation of items such as:
 - i.) Welder testing and qualifications and maintenance of records thereof.
 - ii.) Weld examination and maintenance of records thereof in accordance with applicable codes and specifications.
 - iii.) Hydrotests, hydro-pneumatic tests, pneumatic tests, lead and service tests.
 - iv.) Electrical inspection and testing which includes witnessing of Hipot testing, megger testing, AC power factor testing etc.
 - v.) Instrument model/name plate data verification
 - vi.) Instrument installation checkout
 - vii.) Instrument loop checks
 - viii.) Mechanical and electrical equipment bearing flushing and filling.
 - ix.) Mechanical equipment cold alignment checks and rotation verification.
 - x.) Witness verification that piping loads on machinery equipment meet specifications.
 - xi.) Pump installation check out
 - xii.) Coating and lining tests
 - xiii.) Surface preparation, paint application and thickness verification.
- (g) Final checking of installed facilities, completing check out forms, and signing on behalf of the Contractor documents attesting completion of the work, as called for in the Contractor documents.
- (h) Monitoring or inspecting the work of Sub-contractors - This requires pre-award and pre-field start meetings for major subcontracts with

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

- (i) Foundations
 - (ii) Field fabricated vessel
 - (iii) Tanks
 - (iv) Piping
 - (v) Electrical
 - (vi) Instrumentation
 - (vii) Insulation
 - (viii) Painting
 - (ix) Buildings
- (i) Execute Contractor's standard quality tracking program.
 - (j) Perform final check of installed facilities with Purchaser's representatives to verify completeness and accuracy in accordance with P and ID's / Engineering Flow Diagrams and other scope documents as may be required.
 - (k) "Source" inspect/monitor any field award shop fabrication orders as specified.
 - (l) See that proper protective procedures are employed and maintained for early installed equipment and equipment stored in offsite staging areas.

2.6.6 Non-conformances of on-site Fabrication and Installation

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

2.6.7 Calibration of test equipment

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

2.6.8 QA personnel qualification and certification

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

2.6.9 Quality assurance/Quality Control Records

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

2.6.10 Interface with Statutory Authorities

Participation of statutory authorities, which require testing, witnessing and inspection, shall be provided.

2.6.11 Audits

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

2.6.12 Mechanical Completion Acceptance

Contractor shall perform final inspection of the Work in accordance with the Contract documents.

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

2.7 Inspection at Works

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

INSPECTION REQUEST FORM		
From :		
To :		
Attn :		
Dear Sirs,		
Items detailed below are ready for inspection. Please arrange inspection and confirm the date of inspection.		
1.	Purchaser	:
2.	Project	:
3.	Purchaser's order reference	:
4.	Consultant's reference	:
5.	Sub-order reference	:
6.	Sub-contractor's name and full address	:
7.	Place of Inspection (full address)	:
8.	Contact person, telephone no. and fax no.	:
9.	Description of item and quantity	:
10.	Nature of inspection required	:
11.	Proposed date(s)	:
12.	Weekly holiday	:
We confirm that the items have been fully inspected/tested by us at all stages, of inspection as per quality plan, and all material test certificates, QC records, test Reports, calibration records of measuring/testing instruments with tractability to national level are available with us.		
Thanking you and awaiting your confirmation.		
Yours faithfully,		
Cc: Sub-contractor		

	QUALITY ASSURANCE

HYDROGEN GENERATION PLANT	

HYDROGEN GENERATION PLANT-TESTS													
Tests/Check Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Ultrasonic test	RT	Pneumatic test	Hydraulic / Water Fill tests	Assembly / fit up	Dimension	Functional/ operational tests	Performance tests	Other tests	Remarks
H2 PLANT													
A.COMPRESSOR								Y		Y	Y		
1) Casing	Y ³												
2) Crank shaft/connecting rod	Y ³		Y	Y					Y				
3) Piston/Diaphragm			Y ³							Y			
B. DRYING PLANT							Y						
1.)Raw material identification	Y ³		Y ¹		Y ²								
C. HYDROGEN GENERATOR							Y			Y	Y		
D. CELL MODULE							Y			Y	Y		
E. GAS HOLDER	Y ³						Y						
1.Fillet welds/nozzles welds and knuckle portion of dished ends and all butt welds. 2. 100% butt welds and 100% for Tee joints and dished ends welds. 3. One per heat /HT batch. Notes. 1.Quantum of checks shall be 100% unless otherwise specified.													

SL. NO.		COMPONENT/OPERATION		QUALITY PLAN SHEET 1 OF 2		CUSTOMER :		PROJECT		SPECIFICATION :											
						BIDDER/ VENDOR		TITLE		NUMBER :		SPECIFICATION									
						SYSTEM		QUALITY PLAN		TITLE		SECTION									
						CAT.		ITEM AC ELEC.T. MOTORS BELOW 55KW (LV)		VOLUME III		REMARKS									
		CHARACTERISTICS CHECK		TYPE/METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		P		W		V	
1	2	3	4	5	6	7	8	9	10	11											
1.0	ASSEMBLY	1.WORKMANSHIP 2.DIMENSIONS 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE 1.SHADE	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-											
			MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-											
			MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC./ RELEVANT IS	-DO-	2	-											
2.0	PAINTING		MA	VISUAL	SAMPLE	MANUF'R'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-											
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC. 2.OVERALL DIMENSIONS & ORIENTATION	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1	NOTE -1 & NOTE-3										
			MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	NOTE -1 & NOTE-3										
BHEL		PARTICULARS		BIDDER/VENDOR																	
		NAME																			
		SIGNATURE																			

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :		
		SHEET 2 OF 2		BIDDER/ : VENDOR		QUALITY PLAN		SPECIFICATION : TITLE :		
		COMPONENT/OPERATION CHARACTERISTICS CHECK		SYSTEM CAT.		ITEM AC.ELECT. MOTORS BELOW 55KW (LV)		SECTION VOLUME III		
SL. NO.	2	3	4	5	6	7	8	9	10	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW . ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY										
BHEL		PARTICULARS		BIDDER/VENDOR						
		NAME								
		SIGNATURE								
		DATE								
						BIDDER'S/VENDORS COMPANY SEAL				

 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER							QUALITY PLAN NO.: PE-QP-999-145-4036 _____ 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 Visual	I	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 Visual	I	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 Visual	I	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 Visual	I	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-999-145-1036			
												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		\$		P	- Agency Performing the Test.	1	- BHEL
MA	- Major characteristics			W	- Agency Witnessing the Test.	2	- Vendor
MI	- Minor characteristics			V	- Agency Verifying the Test.	3	- Sub-vendor

 STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER		QUALITY PLAN NO.: PE-QP-999-145-1036 _____										
		VOLUME IIB										
		SECTION D										
		REV. NO. 01		DATE: 24.08.2007								
		SHEET 3		OF 8								
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$ P W V			Remarks

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	Powering 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

 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER										QUALITY PLAN NO.: PE-QP-999-145-1036 _____			
												VOLUME IIB			
												SECTION D			
												REV. NO. 01		DATE: 24.08.2007	
												SHEET 4		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				

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		\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics			W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics			V	- Agency Verifying the Test.	3	- Sub-vendor

**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 5	OF	8

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

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 6	OF	8

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

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036	
VOLUME IIB	
SECTION D	
REV. NO. 00	DATE: 23.03.2005
SHEET 7	OF 8

6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector 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 & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipments 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.

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE:	
23.03.2005		
SHEET 8	OF	8

ii) 48 hours test period shall be divided into 4 equal time segments 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.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE II: SUB VENDORS

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.					UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED			
AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT					BHARAT HEAVY ELECTRICALS LIMITED			
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks

1	Hydrogen Generation Skid a) Electrolyser b) Gas Separator c) Catalyst purifier & dryer d) Moisture & gas separator e) Coolers & condensers f) Filters g) DM cum lye tank h) Buffer tank	I	1			AiroxNigen Equipments Pvt. Ltd., India	Ahmedabad			
2	Manifold (for hydrogen and nitrogen)	II	1			AiroxNigen Equipments Pvt. Ltd., India	Ahmedabad			
3	Manifold valves	III				Vanaz, Indofab, techno				CCOE APPROVED SUPPLIER 1
4	Hydrogen cylinder rack	III				AiroxNigen Equipments Pvt. Ltd., India	Ahmedabad			
5	Vacuum Pump	II				Joyam Engineering, Dicon products	Ahmedabad, Delhi			

1

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.				UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED				
AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT				BHARAT HEAVY ELECTRICALS LIMITED				
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks
6	DM Water cum Lye Making Pump	II				Unique Dosing	Maharashtra			MOTER 1.1KW
7	Hydrogen Gas Compressor (Diaphragm type)	II				Beijing Yitong Huizhi Compressor Manufacturer Co. Ltd.	China			MOTER 5.5 KW
8	Lye circulation pump	III				Precision engineering	Maharashtra			MOTER 1.1 KW
9	Chiller	III				Airox Nigen equipments pvt. Ltd.	Ahmedabad			3TR
10	HDPE DM Water Storage Tank	III				Sintex/Kelvin /joemillars/ kalika	Ahmedabad			
11	Hydrogen & Nitrogen Cylinders	III				EKC, Rama Cylinder, CCOE approved supplier	India			CCOE APPROVED SUPPLIERS

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.					UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED			
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		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks
12	Valves (Ball, Needle, Check, any other valve)	III				L&T,Audco, Pedlock, GIC,sanket gasequipments	Chennai, Maharastra, Gujarat			
13	Pipe, Structural steel, Nut bolts, Clamps & Fittings etc.	III				Airox approved supplier	Ahmedabad			
14	Compressor Motor	III				Crompton Greaves, ABB, Bharat Bijli, LHP	India, China			MOTER 5.5 KW FLAME PROOF
15	Vacuum Pump Motor	III				Crompton Greaves	Mumbai			1.1 KW FLAME PROOF
16	Lye circulation Pump Motor	III				Crompton Greaves, Hindustan	Mumbai, Kolkata			1.1 KW FLAME PROOF

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AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT					BHARAT HEAVY ELECTRICALS LIMITED			
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks
17	DM Feed cum lye Pump Motor	III				Crompton Greaves	Mumbai			1.1 KW FLAME PROOF
18	JunctionBox(FlameProof/ Non- FlameProof)	III				ExEC, Flexpro, Baliga,	India	1		
19	CableGland(Flame Proof/Non-FlameProof)	III				Airox approved supplier	India			
20	CableLugs(FlameProof/ NonFlameProof)	III				Airox approved supplier	India			
21	Cable(Power,Control, Instrumentation) Within skid	III				Polycab, KEI,Delton				DELTON ACCEPTABLE FOR CONTROL CABLE ONLY

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.					UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED			
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		REV. NO.:02	DATE 02.06.2020							
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22	CableTray (Skid mounted)	III				Airoxapproved supplier				
23	PressureGauges	III				Gauge Bourdon, HGuru, AN Instrument, Baumer				
24	PressureSwitch (Compressor Mounted)	III				OEM approved vendor				
25	PressureTransmitter	III				Honeywell, Emerson (Rosemount), ABB, Yokogawa				
26	DifferentialPressure Transmitter/ Level Transmitter	III				Honeywell, Emerson (Rosemount), ABB, Yokogawa				

SUB VENDOR LIST FOR HGP

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AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT					BHARAT HEAVY ELECTRICALS LIMITED			
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks
27	TemperatureGauge	III				Gauge Bourdon, Baumer, Wika , H Guru				
28	RTD with Temperature Transmitter (skid mounted)	III				GIC (Thermal Instrument)				
29	LevelGauge	III				OEM/Main contractor approved vendor.				
30	Conductivity meter for DM Water	III				OEM/Main contractor approved vendor				
31	DewPointMeter	III				GE Sensing,	USA/Ireland,			

SUB VENDOR LIST FOR HGP

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AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT				BHARAT HEAVY ELECTRICALS LIMITED				
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks
32	SolenoidValves, COV	III				Rotex, Asco,	Ahmedabad, India			
33	OxygenTraceSensor	III				City, Southland sensing	UK, USA			
34	HydrogenLeakDetector	III				UPL, Applied Techno,	Vapi/Mumbai			
35	Instrument’sFitting	III				Airox approved source				
36	Rectifier Transformer panel	I	2			Ruttonsha	Vadodara			
37	AC	III				Bluestar, LG, Voltas				MAIN SUPPLIER APPROVED SOURCE

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.					UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED			
AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT					BHARAT HEAVY ELECTRICALS LIMITED			
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks
38	Ventilation Fan	III				OEM Approved supplier				
39	Battery Charger	I				Eltech, Chabbi Electricals, Masstech, HBL, Dubas, Amara raja, Vertiv, Ruttonsha International Rectifier Ltd				
40	Battery	I				HBL, Exide, AMCO				
41	Instrument air compressor	III				Airox approved supplier				
42	Cylinder testing apparatus	III				Airoxnigeneq uipmentspvt ltd	Ahmedabad			

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.					UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED			
AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT					BHARAT HEAVY ELECTRICALS LIMITED			
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks

43	Mini UPS for OWS/EWS	III				Airox approved supplier				
44	PLC Hardware and software	III				Schneider, Siemens, GE, Rockwell, Honeywell, ABB, Fuji Electric				
45	PLC Integration	2 I			2	NTPC approved sources	India			
46	PLC Panel	III			2	Pyrotech/Rittal/Hoffman	India			
47	Computer	III				Dell , HP, Lenovo				
48	Printer	III				HP, Canon				
49	Table for computer / furniture	III				Airox approved supplier				

SUB VENDOR LIST FOR HGP

		PROJECT: 1X660 MW UPRVUNL PANKI TPS EXTN.					UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAN LIMITED			
AIROX NIGEN EQUIPMENTS PVT. LTD.		PACKAGE:HYDROGEN GENERATIONPLANT					BHARAT HEAVY ELECTRICALS LIMITED			
		DOC NO.: 9962-001-PE-110-QVM-Q-502								
		REV. NO.:02	DATE 02.06.2020							
Sr.No.	Item	QP/ Insp. Cat.	QPNo.	QPSub. Schedule	QP Approval Schedule	Proposedsub- supplier	Place	Sub- supplier s approval status/ category	Sub- supplier Details submiss ion schedul	Remarks

LEGENDS:-

QP/INSPNCATEGORY:

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

CAT-II: For these items the Quality Plans are approved by Owner, however no final inspection shall be done by owner. Final acceptance by Owner shall be on the basis of review of documentation as per approved QP.

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



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

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.
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.



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1X660 MW PANKI TPS EXTN.

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SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE III: FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

The Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements stipulated for various equipment covered in this specifications.

The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

The bidder shall demonstrate all the guarantees covered herein during demonstration test / PG test.

The various tests which are to be carried out during demonstration tests are listed in the specification. The guarantee tests shall be conducted by the bidder at site in presence of BHEL/ CUSTOMER. All costs associated with the tests shall be included in the bid price.

In case during demonstration test /PG test, it is found that the equipment/system has failed to meet the guarantees, the bidder shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL/ CUSTOMER and re-conduct the demonstration test(s) / PG test with BHEL/ CUSTOMER's consent.

Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

Hydrogen Generation Plant

- i. Capacity and discharge pressure of hydrogen gas compressors at its rated duty point shall be demonstrated and proved at site.
- ii. Electrolyser & rectifier capacity and power consumption shall be demonstrated at site.
- iii. Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of hydrogen shall be demonstrated at site.
- iv. Hydrogen generation plant capacity (stream wise) shall be demonstrated at site.
- v. Vibration level and noise level of hydrogen gas compressors shall be demonstrated at site.



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SPECIFICATION NO. PE-TS-426-168-A001

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REV. NO. 00

ANNEXURE IV : DRAWING DOCUMENTS DISTRIBUTION PROCEDURE

ANNEXURE-VI
DOCUMENTS DISTRIBUTION SCHEDULE

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

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

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



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

Note:

- Quantity of prints may change during detailed engineering stage based on BHEL / Customer requirement. However, the same will be adhered by the bidder without any delivery/commercial implication to BHEL.
- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.
- Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.
- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copies whichever is later.
- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.
- Bidder has to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.
- Bidder to submit instrument schedule, cable schedule and valve schedule in MS- Excel format during detailed engineering. Bidder to also furnish the auto cad copy / MS-word (as applicable)/MS-Excel (as applicable) of the following documents after award of contract. However, any other auto cad copy/MS-Excel/MS-word of any other document as per the insistence of BHEL / customer will also be submitted by the bidder without any delivery/commercial implication to BHEL.
 - P&IDs.
 - Equipment lay out of the hydrogen generation plant.
 - Equipment Cable tray layout for hydrogen generation plant
 - Equipment earthing layout hydrogen generation plant
 - Civil scope drawings.
 - Piping lay out drawing for hydrogen generation plant.
 - Any Other Dwg/Docs as required.



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REV. NO. 00

ANNEXURE V: PAINTING SPECIFICATION

CHAPTER 7: PAINTING

1.0 SCOPE

This section covers the painting requirements for the power plant equipment, structures, piping etc. and any other surface required to be painted. The painting system should ensure optimal protection of the installation with minimum need for maintenance, environmental friendly & easy to apply.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS contract for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job:

IS: 5	:	Colours for ready mixed paints and enamels
IS: 101	:	All Parts and Sections for paint testing
IS: 1303	:	Glossary of terms relating to paints
IS: 2379	:	Colour code for identification of pipelines
IS: 1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS: 2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS: 6278	:	Code of practice for white washing and colour Washing
IS: 13183	:	Aluminium Paint, heat Resistant specification
IS: 158	:	Ready mixed paint, brushing, bituminous, black, Lead free, acid, alkali, water and heat resisting
IS: 2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS: 104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS: 2932	:	Enamel, synthetic, exterior (a) undercoating (b) finishing.
IS: 2629	:	Recommended Practice for Hot Dip Galvanising
BS EN ISO 14713	:	Code of practice for protection of iron & steel structure against corrosion
ISO 8501-1	:	Preparation of steel substrates before application of paint & related Products. Part-1: Rust grades & preparation grades of uncoated steel substrates & steel substrates after overall removal of previous coatings
ISO 8502-3	:	Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)
ISO 12944 (Part 1 to 7)	:	Corrosion protection of steel structures by Protective paint systems
SSPC	:	US Specifications of Steel Structures Painting Council, SSPC Volumes I and II
SSPC-SP-08	:	Surface preparation by Pickling
NORSOK M-501	:	Surface preparation & Protective coating
ISO 20340	:	Pre-Qualification test
ASTM	:	American Standard Test Method for paints and coatings
AWWA	:	American Water Works Association

In the event of conflict between the Codes and Standards referred to in the specification and the requirement of this specification, the latter shall govern. Statutory and Local regulations shall be strictly followed in selection and application of paint.

3.0 GENERAL

- 3.1 This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).
- 3.2 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.
- 3.3 The paint to be applied shall be approved by Customer / Engineer.
- 3.4 All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.
- 3.5 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:
 - 1. Surface preparations
 - 2. Film thickness (min and max)
 - 3. Min and max recoating intervals at relevant temperatures
 - 4. Mixing ratio, thinner details and coating repair systems
- 3.6 The sample for testing the paint being used may be taken by the customer at any time.
- 3.7 In general Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish in accordance with the requirements of this specification.
- 3.8 For equipment that has received shop prime coat, touch-up prime coat and additional coats shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.
- 3.9 Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter. Damage to other surfaces or equipment shall be repaired by the vendor.
- 3.10 The Contractor shall submit the following for review and approval by the Customer:

1. Manufacturer's recommended paint scheme for the project
2. Latest published product & instructions for application data,
3. Procedures for surface preparation and application.
4. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
5. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

- 3.11 The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.
- 3.12 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.
- 3.13 Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.
- 3.14 It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.

4.0 PREPARATION OF SURFACES

- 4.1 All surfaces to be painted shall be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust, weld spatters, sharp edges and any other foreign matter. Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.
- 4.2 Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.
- 4.3 The blast cleaned surface shall be checked for signs of salt contamination as per ISO 8502-6 & 9. The maximum allowable level of contamination shall be 20 mg/m². Surfaces that do not meet these criteria shall be reprocessed.

Mechanical Cleaning:

Manual/power tool cleaning shall be done as per grade St-2 or St-3, of ISO 8504-3. This method to be used for repair painting or on already painted

surface and in case of usage on new construction painting prior approval may be obtained from purchaser/engineer.

	Condition of surface	ISO 8504-3	SIS 055900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted and pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted and pitted	D St3	D St3	SP3

- i) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.
- ii) Grade St-3: very thorough scraping and wire brushing, machine brushing, grinding etc. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.

Blast cleaning:

Compressors: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110deg C. The blasting activity shall be performed at ambient temperatures above 5°C and relative humidity less than 85%. Steel temperature shall be 3°C above dew point. Necessary safety precautions for equipment and operator shall be adhered to.

Abrasives: Abrasives used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives may be chilled iron grit or shot steel and malleable iron grit and shots non metallic abrasive (aluminium oxide, copper slag, garnet etc.).

Removal of mill scale and rust using abrasives such as grit or shot under high pressure. The grade of blasting performed in line with the approved painting scheme.

Surfaces to be coated shall be free of all grease, oil, loose rust, and loose mill scale. Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Coating Schedule. Oil and grease shall be removed by solvent cleaning method as outlined in SSPC - SP - 1 prior to blasting.

The quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the surface profile depth and cleanliness. Abrasives shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertaining to the work.

Profile measurements for abrasive blast cleaned surface shall be made with a Profile comparator and permanent record shall be maintained with Testex Press-O-Film.

Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and

commencement of painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

After blasting cleaning, depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 mm may be used.

The grades of surface finish:

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Paint Application

General:

Paints and other coating materials shall be applied in accordance with the paint manufacturer's instructions. The surface preparation and painting system shall be as described in ANNEXURE with the following exceptions:

- Nameplates, code stampings and push buttons
- Concrete brickwork, tile, and glass unless specified by the Purchaser / Engineer
- Non-ferrous materials
- Austenitic stainless steel
- Plastic and / or plastic coated materials
- Insulated surface of equipment and pipes except colour coating wherever required
- Any surface specified by the Purchaser / Engineer not to be painted.

Paint Application Requirements

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mix ratio, the method of application, and the use of thinners and over coating times.

Paint application shall be by brush, roller or spray gun. Local regulations regarding spray and roller coating shall be observed. A smooth uniform film shall be applied to the surfaces to be coated.

Painting shall be performed when the temperature of the surface is greater than 3°C above the dew point of the surrounding air and relative humidity of the air is less than 85% unless local conditions dictate otherwise and the Customer is in agreement. Guidance on the estimation of the probability of condensation can be found in ISO 8502-4. The measurement of these conditions is the responsibility of the Vendor.

In addition, paints shall not be applied under the following conditions:

- When the surface temperature is greater than 60 °C (unless a higher temperature is agreed by the paint manufacturer)
- When the air temperature is less than approximately 5°C, (depending on local conditions)

- When there is the likelihood of an unfavourable change in weather conditions within two hours after painting
- When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.
- When the available light is less than 500 lux.

Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld areas shall be taped/one coat of weldable primer for distance of 50 mm either side of the weld line.

When zinc rich primers are used, care shall be taken to mask to avoid any possibility of over spraying onto duplex, austenitic stainless steels; nickel alloys or 9% nickel steel components.

Two pack coatings like Air drying epoxy, Polyurethane coatings etc shall be mixed in the ratio recommended by manufacturer to ensure proper and complete curing of the coatings. The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing / agitation and not the reverse. Power agitation is preferred over hand mixing.

Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed. Excess thinner is not recommended, as increase in volume, leads to lower DFT, sagging, longer curing time, etc.

Coating containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by continuous use of a mechanical agitator whilst being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

Transport and erection of painted structures shall be carried out only after the drying time specified by the paint manufacturer has elapsed. Handling & packing of painted material shall be appropriate to avoid damage to painting, such as the use of non-metallic slings, etc for handling and by minimising handling after painting. All steel equipment shall be provided with priming or coating system to protect the steel surface during transport, storage, installation and construction.

Spray Application

Airless or pneumatic spray applications are preferred methods of application. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90° to the surface being painted.

Approval of Purchaser / Engineer shall be obtained during spray painting which may cause interference to other works. If spray painting is to be carried out, the following shall be taken into account:

The correct spray tips, air pressures, etc, as recommended by the equipment supplier, shall be used.

Conventional air spray equipment is used, the correct combination of air volume, air pressure and fluid flow to give good atomisation to be ensured to

get a defect free painted surface. The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method as most paints have to be thinned to a suitable viscosity for satisfactory atomisation, and so lose their high build properties. Vendor shall follow manufacture's instruction.

Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied as paint in the tank can be prevented from settling, reduces application time and also enables the gun to be turned to any angle to coat objects effectively without spilling paint.

Airless spray is recommended as high build coatings can be applied without thinning, very rapid application is possible, giving an economic advantage, compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and less dust and fume hazards.

Each coat shall be applied uniformly and completely over the entire surface. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface re-sprayed.

Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

Brush application

Brush application may be used under the following circumstances:

- When areas cannot be properly coated by spraying for reasons such as material or environmental considerations
- For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application
- For "touch up" or repairs to localize damaged paint or areas of incorrectly applied paint
- Where the paint manufacturer considers the coating material suitable for brush application.

Brushes shall be of a style and quality that will permit the proper application of paint.

Brush applications should be done in two passes that are perpendicular to each other 'wet on wet' so that a smooth coat, as near uniform in thickness as possible, is obtained thereby avoiding running and droplets. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.

During the application of each coat, all areas such as corners, edges, welds, small brackets, bolts, nuts and interstices shall receive additional paint to ensure that these areas have at least the minimum specified dry film thickness and to ensure continuity of coating.

Roller application

Roller application shall only be used on relatively large surface areas and only if spraying is not an option. Roller application shall only be used if the first or priming coat of paint has been applied by brush. Roller application shall be in accordance with the paint Manufacturer's instructions.

Coating materials

The selected coating materials shall be suitable for the intended use and shall be selected after an evaluation of all relevant aspects such as

- Corrosion protective properties
- Requirements to health, safety and environment
- Properties related to application conditions, equipment and personnel
- Experience with the coating materials and coating system.

All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions. Performance standard as listed below shall be established by paint manufacturer the records shall be submitted for review.

- Adhesion test (pull off test)
- Flexibility test
- Salt spray test (min 1000 Hrs)
- Water absorption test
- UV resistance test (external coating)
- Cathodic disbonding test (internal coating)
- Abrasion test (internal coating)
- Impact resistance test
- Sea water immersion test (structures in tidal, splash zone and conveying sea water)

Each product shall have a batch number showing year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, State or Local regulatory bodies for the products. All vehicle components for use in the manufacture of paints and enamels shall meet the ASTM/ ISO Specification except as otherwise stated coating systems shall be selected as per corrosivity category listed in the table below. Coating systems are tabulated in ANNEXURE and shall be pre-qualified in accordance with specification. Coating systems/ alternative coating systems may be re-subjected to pre-qualification, at the discretion of OWNER/ ENGINEER. The specified coating systems, the number of coats and the coating film thicknesses given in Annexure are minimum requirements Top coat colors should be in accordance with Annexure.

Gratings and step threads

- i) Surface preparation

Gratings and step threads shall be cleaned by acid pickling as per SSPC-SP-08.

- ii) Hot dip galvanising

The hot dip galvanising shall be done as per IS 2629 .The average mass of coating shall be 610 gms/m².

iii) Post galvanising treatment

Immediately after galvanising, post treatment such as chromating shall be applied to retard white rust attack.

iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A 780.

CORROSIVITY OF ENVIRONMENTS

Corrosivity category		Mass loss per unit surface (per year of exposure)	
		Mass loss g/mm ²	Thickness loss µm
C2	Low	>10 to 100	>1.30 to 25
C3	Medium	200-400 g/m ²	(25-50µm)
C4	High	400-650 g/m ²	(50-80µm)
C5	Very High Industrial & marine	650-1500g/m ²	(80-200µm)

Tests required for evaluation of acceptance of coating materials:

TABLE -1

PERFORMANCE TEST OF PAINT

SL. No.	Test	ASTM TEST METHOD
1.0	Abrasion Resistance: (topcoat only)	ASTM D4060
2.0	Adhesion:	ASTM D4541
3.0	Dry Heat Resistance:	ASTM D2485
4.0	Flexibility: (topcoat only)	ASTM D522, 180° bend
5.0	Pencil Hardness: (topcoat only)	ASTM D3363
6.0	Salt Fog Resistance:	ASTM B117, 1000 hours
7.0	Weather Resistance:	ASTMG23 Type D
8.0	Test	ASTM Test Method
9.0	Density	D 1475
10.0	Dipping properties	D 823
11.0	Drying time	D 1640
12.0	Flexibility	D 1737/D 522
13.0	Hardness	D 3363
14.0	Adhesion (pull off test)	D 4541
15.0	Abrasion resistance	D 968/D 4060
16.0	DFT/Coat	As per SSPC Guidelines
17.0	Storage Stability	D 1849
18.0	Resistance to	
	i) Humidity for 2000 hrs.	D 2247
	ii) Salt Spray for 2000 hrs.	B 117
	iii) Accelerated Weathering	D 822

INSPECTION:

Inspection will be performed by an inspector authorised by Purchaser / Engineer. Paint materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specification and shall be accompanied by manufacturer's test certificates.

The painting work shall be subjected to inspection by purchaser / engineer at all times. The vendor shall offer following stage of inspection:

- Surface preparation
- Primer application
- Subsequent coats
- Paint qualification test

Vendor shall provide the expert technical services of the paint manufactures as and when required by purchaser / engineer to ensure both the surface preparation and applications are carried out as per their recommendations. This service shall be provided without any obligation to purchaser.

The following coating inspection & test shall be carried out:

1. Ambient and steel temperature, relative humidity and dew point min twice in a shift.
2. Surface finish & profile check each component or once per 10 m2 after surface preparation.
3. Salt contamination test - Free from salt contamination.
4. Dry Film Thickness as per ISO 2808 No.6.
5. Holiday Test as per ASTM D 5162/ NACE RP 0188.
6. Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

6.0 SUGGESTED COLOUR CODES FOR PAINTING:

Sl. No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
1.0	Structures, platforms, ladders and handrails	Dark Admiralty Grey	632		
2.0	Boiler casing, ESP and ducting	Nut Brown	413		
3.0	Fans, pumps, motors,	Light Grey	631		
4.0	Tanks (without insulation and cladding)				
4.1	Outdoor	Aluminium			
4.2	Indoor	Light grey	631		
5.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631		
6.0	Switchgear	Light grey	631		
7.0	Control & relay panels	Light grey	631 78 of IS1650		
8.0	Turbine	Golden	356		

Sl. No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
		Yellow			
9.0	Generator & exciter	Light grey	631		
10.0	Transformers	Aluminium			
11.0	Machinery guards	Signal red	537		
12.0	Crane				
12.1	Crane structure	Golden Yellow	356		
12.2	Trolley and hook	Crimson	540		
13.0	Piping (without insulation and cladding)				
13.1	Water System				
13.1.1	Boiler feed	Sea green	217		
13.1.2	Condensate	Sea green	217	Light brown	410
13.1.3	Bearing cooling water	Sea green	217	French blue	166

Notes:

1. This colour code basically refers to IS: 2379 for piping with necessary modifications.
2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

PAINTING SCHEME FOR C2 AND C3 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120°C	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2		260µ
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120 µ	--	--	--	260µ
3.	Insulated parts exposed to temp >120°C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Work shop	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120 µ	--	--	--	260µ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Aliphatic poly urethane	2	80 µ	360µ
6.	Coal Handling Plant	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	poly urethane	2	60 µ	260µ
7.	Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
8.	Un insulated silencer, steel stacks >120°C	Sa 2 ½	Ehthy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
10.	Burried piping (External)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4.0m m
11.	Burried piping (Internal)	Sa 2 ½	Solid rigid poly urethane 500 µ									500µ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ

14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4. mm
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
18.	For insulated piping <125°C	Sa 2 ½	Polyamide cured epoxy coating	2	250 µ							250µ
19.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
20.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
21.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising 80µ									80µ

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance

PAINTING SCHEME FOR C4 AND C5 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120°C	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
3.	Insulated parts exposed to temp >120°C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Work shop	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
6.	Coal Handling Plant	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	2	200 µ	Poly urethane	2	60 µ	340µ
7.	Coal Fuel pipings	Sa 2	Ethyl Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
8.	Un insulated silencer, steel stacks >120°C	Sa 2 ½	Ethyl Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
10.	Buried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel									4.0 mm
11.	Buried piping (internal)	Sa 2 ½	Solid rigid poly urethane 500 µ									500µ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	2	200 µ	Poly urethane	2	60 µ	340µ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4.0

												mm
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
18.	For insulated piping <125°C	Sa 2 ½	Polyamide cured epoxy coating	2	250 µ							250µ
19.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
20.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
21.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising coating Wt. 610 gms/M ² (coating thickness of 80µ)									80µ

*** Note:** Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE VI: MANDATORY SPARES LIST



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

SL. NO.	DESCRIPTION	TOTAL QUANTITY INCLUDED FOR THE PROJECT
1)	Water Electrolyser	
a.	Electrolytic cells complete with all accessories and safety features	One complete module (Electrolyser) in case replacement of cells in the electrolyser cubicles is not possible at power station site. Otherwise, 10% of the no. of cells provided in each Electrolyser unit.
b.	Insulators tubes for gas outlets and tie rods	4 sets of each type
c	Thermometers for measuring electrolyte temperature	1 no of each type/size
d	Glass tube (with float) front	2 no of each type/size
e	Gaskets	6 sets of each type/size
f	Feed water Valve and U-tube Assembly	1 set of each type
g	Nuts and washers	2 sets of each type/Size
h	Insulation rings	4 nos of each type/Size
i	Diaphragms	4 sets of each type/Size
2)	Rectifier	
a	Diodes/Thyristors	6 nos
b	Fuses for diodes/Thyristors	12 nos
c	Input power fuses	6 nos
d	Control contactors	3 nos
e	Main contactors	2 nos
f	All electronic Cards and power supply card for rectifiers	1 no of each type
3)	Pump (For each Service)	
a	Pump bearings	2 each
b	Motor bearings	2 each
c	Pump Shaft	1 each
d	Gland complete with Packing	2 each



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

4)	Spares for Compressor	
a	Suction and discharge Valves (complete)	2 sets for each stage /size/type.
b	Seats of suction and Discharge Valves	2 sets for each stage /size/type.
c	Bearings of Drive end, non-drive end, intermediate and motor	2 sets of each type/rating
d	Complete Diaphragm head Assembly	2 sets of each stage
5	Motor for compressor	1 no
6	Filter element	2 sets of each type/rating
7	Dryer desiccant	2 complete fill
8	Hydrogen manifold valves	4 nos of each type/ Size
9	Adsorption drier After filter elements with gaskets/O rings	4 sets
10	SS Pipes and connectors used in Compressor, dryer, dust filter etc	5% of each size/ type
11	Complete set of valves for isolation for filters, dryers, instruments and drain valves	1 no of each type/rating
B.	ELECTRICALS ITEMS	
1	Terminal plates	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW
2	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher
3	Bearings (DE and NDE) for each type and rating of motor	4 sets
4	Stator winding coils for all type of LT motors	One (1) set.
5	Dust seals and gaskets for each type of motors	Three (3) stes.
C.	I & C Mandatory spares	
1.0	PLC System	



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

1.1	Communication Processor Module	1 No. for each type
1.2	Binary Input Card	10% of total nos. used in the system or minimum 4 (four) nos. whichever is more.
1.3	Analog Input Card (4 to 20 mA type)	10% of total nos. used in the system or minimum 2 (two) nos. whichever is more.
1.4	Analog Input Card (RTD input type)	10% of total nos. used in the system or minimum 2 (two) nos. whichever is more.
1.5	Binary Output Card for contact	10% of total nos. used in the system or minimum 4 (four) nos. whichever is more.
1.6	Binary Output Card for Voltage (24VDC)	10% of total nos. used in the system or minimum 4 (four) nos. whichever is more.
1.7	Analog Output Card (4 to 20 mA type)	10% of total nos. used in the system or minimum 2 (two) nos. whichever is more.
1.8	Interposing Relay	10% of total nos. used in the system or minimum 4 (four) nos. whichever is more, of each type and rating.
1.9	Output Relay modules / Relay Board & Auxiliary Relay	10% of total nos. used in the system or minimum 4 (four) nos. whichever is more.
1.1	Communication Modules	1 No. for each type
1.11	Prefab-cable with connector for CPU, Communication Card and I/O racks	1 No. for each type
1.12	Networking Modules / Components / Switch	1 No. for each type
1.13	Power Supply Units for CPU, Communication Card, I/O racks and field IO interrogation.	10% of total nos. used in the system or minimum 2 (two) nos. whichever is more for each type and rating.
1.14	RAM Backup Battery	2 (two) nos.
1.15	Special Fuse for the Cards	Each type/ rating of fuse, 25% of total nos. used in the system or minimum 25 nos. whichever is more.
2.0	Field Instrument	
2.1	Electronic Transmitters (Pressure, Differential Pressure, Flow, Level etc.)	1 (One) no. complete set for each type and model / range used in the system
2.2	Switch (Pressure, Differential Pressure, Level, Flow, Temperature etc.)	10% or 1 (One) no. whichever is higher of each type & model / range used in the system



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

2.3	Thermocouple (if applicable)	10% of each type and length of the total nos. used in the system or minimum 2 (two) nos. whichever is more.
2.4	RTD	10% of each type and length of the total nos. used in the system or minimum 2 (two) nos. whichever is more.
2.5	Solenoid Valve	
2.6	Gauge (Pressure, Differential Pressure, Temperature, Level, Flow)	10% of total nos. used in the system or minimum 1 (one) no. whichever is more for each type and range.
2.7	Air Filter Regulator complete set with pressure gauges	10 Nos.
2.8	Rotameter	10% of total nos. used in the system or minimum 2 (Two) nos. whichever is more for each type, rating,/model and size used in the system.
3.0	Analysers / Detectors	
3.1	Conductivity Analyser	1 (One) no. complete set for each type and model / range used in the system
3.2	Dew Point Analyzer	1 (One) no. complete set for each type and model / range used in the system
3.3	Trace Oxygen Analyzer	1 (One) no. complete set for each type and model / range used in the system
3.4	Trace Hydrogen Analyzer	1 (One) no. complete set for each type and model / range used in the system
3.5	Comestible Gas / Hydrogen Gas Leak Detector	1 (One) no. complete set for each type and model / range used in the system
4.0	Control Valves, Actuators and Accessories (for each size, rating, type)	
4.1	Pneumatic Diaphragm, gasket etc.	2 (two) nos. for each type of Actuator
4.2	Gland Packing	1 (one) set for each type of Control Valve



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

4.3	Solenoid valves, position transmitters, limit switches, E/P converters, positioner, Air lock relay etc. of each type	10%
5.0	Cables	
5.1	Instrumentation & Control cables (Type wise)	10% of quantity for each type
5.2	Interface cables with connecting plug for each type of peripherals or I/O hardware	10% of quantity for each type
5.3	LT Power cable	500 meter of each type, size of cable
6.0	UPS	
6.1	HRC fuses/ MCBs	03 Sets of each type and rating.
6.2	Semi conductor fuses	06 Sets of each rating
6.3	Electronic cards/modules	02 nos. of each type & function
6.4	Thyristors and power transistors	01 no. of each type
6.5	Power diodes	02 Sets of each rating
6.6	Auxiliary relays	02 Nos. of each type & rating
6.7	Filter Capacitors	01 Set
6.8	Filter chokes	01 Set
6.9	AC & DC switches	02 Nos. of each type & rating
6.10	MCCB/ACB	01 No. of each type
6.11	Push buttons	02 Nos.
7.0	Annunciation System	
7.1	Lamp Box with Facia& Lamps (LED type)	10% or 2 nos. whichever is higher
7.2	Electronic Module	10% of minimum 1 (one) no. whichever is more
7.3	Hooter	1(one) No.



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

Note:-

- i) Wherever quantity has been specified percentage (%) the quantity of mandatory spares to be provided by the bidder shall be type (as the case may be) in the same proportion of the main population. In case the quantity so calculated happens to be fraction, the same should be distributed into various ranges /size /rating/next higher whole number.
- ii) Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
- iii) Interchangeability and Packings: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares shall include all mounted accessories like components, boards, add on items, fittings, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require additional item. All electronic modules should be pre set and/or preprogrammed for ready use at site. Alternatively, suitable instruction sheet indicating details of required PCB jumper position, BCD which is setting, EPROM/ROM listing etc should be packed along with each module. Also a caution mark sign should be put on all such module which needs presetting/ re programming before putting them in to service. The spare shall be treated and properly packed for long term storage.
- iv) In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed as per the above list.
- v) Identification: Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE VII: DRAWING/DOCUMENTS SUBMISSION SCHEDULE



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

S.NO.	DRAWING NO	DRG TITLE	APPROVAL CAT	SCH WEEK AFTER LOI	SIZE
1	PE-VO-426-168-A001	GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS AND FLOOR DRAIN DETAILS OF HYDROGEN GENERATION PLANT	A	4	A1
2	PE-VO-426-168-A002	PIPING & INSTRUMENTATION DIAGRAM WITH I/O LIST OF HYDROGEN GENERATION PLANT	A	4	A3
3	PE-VO-426-168-A003	DESIGN & CONTROL PHILOSOPHY OF H2 PLANT ALONG WITH INTERLOCK AND LOGIC DIAGRAM	A	6	A4
4	PE-VO-426-168-A005	GA FOR COMPRESSORS WITH MOTOR OF HYDROGEN GENERATION PLANT	A	10	A4
5	PE-VO-426-168-A006	DATA SHEET, GA,& CIRCUIT DIAGRAM OF RECTIFIER TRANSFORMER OF HYDROGEN GENERATION PLANT	A	6	A4
6	PE-VO-426-168-A007	PLC DATASHEET, PLC- OWS/PRINTER FURNITURE BOM, PLC CATALOGUE, OWS & PRINTER CATALOGUES, PLC PANEL GA (INTERNAL & EXTERNAL), PANEL HEAT DISSIPATION DATA	A	12	A3
7	PE-VO-426-168-A008	GA OF FEED WATER, KOH TANK OF HYDROGEN GENERATION PLANT	A	6	A4
8	PE-VO-426-168-A009	GA OF H2 MANIFOLD OF HYDROGEN GENERATION PLANT	A	6	A4
9	PE-VO-426-168-A010	GA N2 PURGING MANIFOLD OF HYDROGEN GENERATION PLANT	A	6	A4
10	PE-VO-426-168-A011	GA HYDROGEN & NITROGEN CYLINDER OF HYDROGEN GENERATION PLANT	A	6	A4
11	PE-VO-426-168-A012	GA CYLINDER TEST STATION OF HYDROGEN GENERATION PLANT	A	6	A4
12	PE-VO-426-168-A013	GA VACUUM PUMP OF HYDROGEN GENERATION PLANT	A	6	A4



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

13	PE-VO-426-168-A014	PIPING INSTALLATION AND PIPING LAYOUT DRAWING	A	10	A1
14	PE-VO-426-168-A015	HYDROGEN PLANT INTER-LOCK LOGIC DIAGRAM & CONTROL SCHEMES (BLOCK LOGIC)	A	12	A4
15	PE-VO-426-168-A016	PLC INPUT / OUTPUT SIGNAL LIST, POWER SUPPLY WIRING DIAGRAM	A	12	A4
16	PE-VO-426-168-A018	H2 PLANT WIRING DIAGRAM	A	12	A3
17	PE-VO-426-168-A019	DATASHEET OF COMPRESSOR OF HYDROGEN GENERATION PLANT	A	10	A4
18	PE-VO-426-168-A020	DATASHEET OF INSTRUMENTS & ANALYSERS OF HYDROGEN GENERATION PLANT	A	10	A4
19	PE-VO-426-168-A021	DATASHEET OF MOTORS OF HYDROGEN GENERATION PLANT	A	10	A4
20	PE-VO-426-168-A023	CABLE SCHEDULE & INTERCONNECTION OF HYDROGEN GENERATION PLANT	A	16	A3
21	PE-VO-426-168-A026	INSTRUMENT SCHEDULE OF HYDROGEN GENERATION PLANT	I	10	A4
22	PE-VO-426-168-A030	ELECTRICAL LOAD DATA OF HYDROGEN GENERATION PLANT	I	10	A4
23	PE-VO-426-168-A031	PG TEST PROCEDURE OF HYDROGEN GENERATION PLANT	A	20	A4
24	PE-VO-426-168-A032	O&M MANUAL OF HYDROGEN GENERATION PLANT	A	24	A4
25	PE-VO-426-168-A033	SUB VENDOR LIST & INSPECTION CRITERIA OF HYDROGEN GENERATION PLANT	A	4	A4
26	PE-VO-426-168-A034	GA OF ELECTROLYSER AND PURIFICATION SKID.	A	6	A4
27	PE-VO-426-168-A036	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	I	10	A3
28	PE-VO-426-168-A037	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	10	A3



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

29	PE-VO-426-168-A038	PROCESS GRAPHIC MANUSCRIPTS PLC, PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	A	10	A1
30	PE-VO-426-168-A039	UPS BATTERY CHARGER/ BATTERY DATASHEET, UPS SIZING CALCULATIONS, BATTERY SIZING CALCULATIONS, UPS QAP, UPS TYPE TEST REPORTS ON COMPONENTS	A	10	A3
31	PE-VO-426-168-A040	CABLE TRENCH/ TRAY LAYOUT AND EARTHING DETAILS FOR HYDROGEN GENERATION PLANT WITH DETAILS OF CABLE TRAY ACCESSORIES.	A	12	A1
32	PE-VO-426-168-A041	QAP FOR COMPRESSORS WITH MOTOR OF HYDROGEN GENERATION PLANT	A	10	A4
33	PE-VO-426-168-A042	QAP FOR PLC OF HYDROGEN GENERATION PLANT	A	12	A4
34	PE-VO-426-168-A043	QAP OF RECTIFIER OF HYDROGEN GENERATION PLANT	A	6	A4
35	PE-VO-426-168-A046	QAP OF ELECTROLYSER AND PURIFICATION SKID	A	6	A4
36	PE-VO-426-168-A048	QAP FOR HYDROGEN GEN PLANT (BALANCE OF ITEM)	A	10	A4
37	PE-VO-426-168-A049	PLC QUALITY PLAN & FAT PROCEDURE	A	10	A4

Notes:

1. A= APPROVAL. I = INFORMATION.
2. Any additional drawings-documents required during detailed engineering stage shall be provided by bidder without any commercial, technical and delivery implication to BHEL and customer.
3. Non-submission of the document as per attached schedule will attract LD.
4. Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure IV of this specification. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end
 - Internet explorer version – Minimum Internet Explorer 7
 - Internet speed – 2 mbps (Minimum preferred)
 - Pop ups from our external DMS IP (124.124.36.198) should not be blocked
 - Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)
 - DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
 - For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html>



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE VIII: DM AND COOLING WATER ANALYSIS



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

S.No.	Characteristics	Value
1.	Silica (Max.)	0.02 ppm as SiO ₂
2.	Iron as Fe	Nil
3.	Total hardness	Nil
4.	pH value	6.8 – 7.2
5.	Conductivity	Not more than 0.1 excluding the effects of free CO ₂



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE IX: LIST OF TOOLS & TACKLES (AS APPLICABLE)

Bidder to consider necessary tools and tackles for mechanical, electrical and control & instrument as per their system requirement. In addition bidder to adhere relevant clauses of tender specification also.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE X: FORMAT FOR OPERATION AND MAINTENANCE MANUAL



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

Bidder to submit operation and Maintenance manual with minimum information as listed in below check list during contract stage.

CHECK LIST FOR OPERATION & 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	
	1.1				
1.	1.2 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	1.3 Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	1.4 Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	1.5 Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	1.6 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	1.7 Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent,				



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

	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				



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1X660 MW PANKI TPS EXTN.

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GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE XI: SITE STORAGE AND PRESERVATION

CHAPTER 10 : STORAGE OF EQUIPMENT / GOODS AT SITE

1.0 SCOPE

- 1.1 This specification details the general guidelines for storage of mechanical and electrical equipment at site from the date equipment are taken over by the CONTRACTOR until the same are erected and handed over to the OWNER.
- 1.2 The equipment covered under this specification shall be stored in the type of storage as recommended by the MANUFACTURER/OWNER/CONSULTANT.

2.0 CONSTRUCTION OF STORES

- 2.1 Normally, the OWNER makes available the space for the CONTRACTOR to construct the necessary stores as specified.
- 2.2 To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise wasteful handling during retrieval of items required for erection.
- 2.3 The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. The CONTRACTOR shall check the satisfactoriness of these facilities prior to monsoon.
- 2.4 The stores sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
- 2.5 In case of storage of certain equipment / materials, it may be necessary to maintain specified temperature ranges. In such cases, it is the responsibility of the CONTRACTOR to provide adequate heating / air conditioning facilities on round the clock basis. The CONTRACTOR shall check that space heaters, heating bulbs and air conditioners are kept energised continuously as applicable. In the event there is a prolonged failure of electric power, rendering such air-conditioners/space heaters inoperative, the CONTRACTOR shall make alternative arrangements to ensure that items under storage do not suffer any damage / deterioration on this account.
- 2.6 Adequate lighting facility shall be provided by the CONTRACTOR in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials entrusted to him by the OWNER. The CONTRACTOR shall carry out regular inventory of materials received, issued and erected and notify the OWNER of any loss when noticed.
- 2.7 The CONTRACTOR shall provide adequate number of competent stores personnel including store-keepers, clerical staff, inspection engineers, watchmen and security staff to efficiently store and maintain the equipment / material entrusted to him.
- 2.8 Where necessary, the CONTRACTOR shall provide necessary space heating and other protective care to equipment in case it will take a long time to haul them

to the stores. Any equipment left in the open under such conditions shall be, if required, covered with tarpaulin.

3.0 MAINTENANCE DURING STORAGE

- 3.1 Where unloading from the carriers and transport to warehouses is excluded from the CONTRACTOR'S scope .The CONTRACTOR shall take over the materials from the OWNER'S storage area / sheds.
- 3.2 Where materials is unloaded by the OWNER before the CONTRACTOR arrives at site or even when the CONTRACTOR is already at site, the OWNER can hand over the material to the CONTRACTOR and thereupon it will be the responsibility of the CONTRACTOR to store and maintain these material in a proper and approved manner.
- 3.3 While taking over the materials, the CONTRACTOR shall carry out inventory and inspection of the same and submit a report of his observations to the OWNER. After taking over of the equipment / materials, the CONTRACTOR is solely responsible for the same until handing over to the OWNER the erected plant and surplus materials, if any. The CONTRACTOR is responsible for maintenance of the equipment / materials in storage, during erection and until commissioning including protection of the same against theft, elements of nature and corrosion damages. In case commissioning of the equipment is delayed, the CONTRACTOR shall be responsible for maintenance of the erected plant and equipment as directed by OWNER / CONSULTANT.
- 3.4 The CONTRACTOR shall repack the equipment after inspection and store the same in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks, preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks.
- 3.5 The CONTRACTOR shall carry out frequent inspection of materials stored and also extend necessary facilities to the OWNER / CONSULTANT to carry out such inspection, when considered necessary. The CONTRACTOR shall implement the suggestions of the OWNER/CONSULTANT in this connection.
- 3.6 At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground by providing good wooden sleepers.
- 3.7 Welded and cast units shall be stored in such manner that there is no danger of distortion.
- 3.8 All special measures to prevent corrosion shall be taken by the CONTRACTOR.
- 3.8.1 Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The CONTRACTOR shall inspect the materials and in case of signs of wear or damages to protective coating, that portion shall be cleaned with carbon tetra chloride or any other approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
- 3.9 While handling the equipment, no dragging on the ground is permitted. The CONTRACTOR shall submit his scheme for handling major pieces of equipment

for approval by the OWNER / CONSULTANT prior to actual handling of the same. In cases where a scheme is recommended by the OWNER / MANUFACTURER, it shall be strictly adhered to.

- 3.10 The CONTRACTOR shall periodically inspect materials with specific reference to
 - 3.10.1 Ingress of moisture and corrosion damages.
 - 3.10.2 Damage to protective coating.
 - 3.10.3 Open ends in pipes, vessels and equipment. In case any open ends are noticed, the CONTRACTOR shall get them capped.
 - 3.10.4 Insulation of electrical equipment. Regular insulation checks are essential and these values shall be properly logged.
 - 3.10.5 Any damages to equipment / materials.
 - a) In case of any damages, these shall be promptly notified to the OWNER. In all cases, the repairs / rectification shall be carried out strictly as directed by the OWNER / CONSULTANT.
 - b) If such repairs / rectification is necessitated due to causes attributable to the CONTRACTOR, such repairs / rectification shall be carried out at no extra cost to the OWNER. In other cases, compensation for such repair / rectification works will be as mutually agreed to.
 - c) In case such damages are attributable to the CONTRACTOR and if, in the opinion of the OWNER/ CONSULTANT, the CONTRACTOR is not competent to carry out necessary repairs / rectification, the OWNER shall get this done by any other agency and recover the expenditure incurred by him from the CONTRACTOR.

4.0 MODES OF STORAGE

Given below are the general guidelines for storage of various equipments under the broad storage classifications. Wherever the specific recommendations of the MANUFACTURER/OWNER/CONSULTANT are at variance with what is indicated below, the former shall prevail.

4.1 Special Storage – Air Conditioned

The following materials are normally stored in air conditioned storage.

4.1.1 Welding Electrodes

These deteriorate under adverse conditions of storage and are preferably stored in air conditioned storage. As an alternative, if approved, these can also be stored in hot boxes / ovens.

It is essential to regularly inspect the conditions of electrodes and ensure that temperature is maintained within specified range at all times.

4.1.2 Ball, needle and roller bearings: These shall be stored in their original packing.

4.1.3 Photographic materials and films: These shall be stored in their original moisture vapor proof packages.

4.1.4 Rubber Goods: These shall be protected against sunlight and artificial light as well as high humidity conditions.

4.1.5 Hydraulic / Electronic equipment / instruments and components - These shall be stored in sealed packages.

4.2 Closed storage

The following materials are normally stored in closed storage.

4.2.1 Cement bags.

4.2.2 All small parts / components liable to be misplaced / lost. These shall include the following:

- a) Small structural cleats, bolts, nuts, washers, etc. High tensile bolts and nuts shall be stored in separate sealed boxes with proper identification to avoid mix up with other items
- b) Pipe hangers, spring hangers, etc. The identification numbers on spring hangers shall be carefully preserved during storage
- c) Stainless steel and copper tubes, pipe fittings, etc.
- d) Electrical clamps, cable boxes, cable glands, ferrules, fuses, control cables, copper cables and grounding strips, push button switches, etc.
- e) Pilot valves, pull rods, keys, control valves. These shall be greased, wrapped in paraffin paper and stored in packing boxes
- f) Turbine governing system components

4.2.3 All loose turbo generator parts, turbine sole plates and packing plates, bolts and studs.

4.2.4 Generator and turbine rotors, stators, bearings, liners, control gears, etc.

4.2.5 Boiler fine fittings, soot blowers, mill and fan bearings, hangers and couplings.

4.2.6 Electrostatic precipitator electrodes, connecting links, etc.

4.2.7 Drive units of regenerative air heaters, fans, mills, etc., motors, pumps, blowers, ejectors and compressors, including those supplied disassembled.

4.2.8 Oil and hydrogen coolers.

4.2.9 Seal oil and gas control system equipment.

4.2.10 All indoor switch gear equipments.

4.2.11 Bus ducts, exciters, excitation system equipment, voltage regulators, circuit breakers, potential and current transformers, lightning arrestors, bushings, storage batteries and cells.

- 4.2.12 All instrument parts such as measuring instruments, controllers and regulators, interlock system, control drive units, gauges, instrument valves, thermocouples and leads.
- 4.2.13 Thermal and insulation materials. Mineral wool, glass wool, castable refractories, fire bricks, asbestos, etc.
- 4.2.14 DM plant chemicals and resins.
- 4.2.15 Synthetic paints. Normally in separate stores.

4.3 Semi-Closed Storage

The following materials are normally stored in semi-closed storage.

- 4.3.1 Condenser tubes stored in boxes.
- 4.3.2 Dust collector elements in boxes.
- 4.3.3 Coal mill liners, shell, coal feeders and gates, separator assembly.
- 4.3.4 Boiler dampers, manhole doors, mountings, casing frames, buck stays, Air pre-heater frames tubes, baskets. Burner panels and burners, Electrostatic precipitator shell, discharge and collecting plates.
- 4.3.5 Fan impellers, large assembled pumps, compressors, crushers, pulleys and idlers, wagon tippler drive assemblies and bearings, outdoor motors, etc..
- 4.3.6 Large C. I. Valves, butterfly valves, stop and control valves, expansion joints.
- 4.3.7 Outdoor switch gears and panels, small transformers, cable tray parts, etc.
- 4.3.8 Crane rope drums, hoists, trolleys. Wire ropes in drums covered with tarpaulin.
- 4.3.9 Bearing stands
- 4.3.10 Conveyor belts

4.4 Open Storage

The following materials are normally stored in open storage.

- 4.4.1 Fabricated and un-fabricated structural steel members, Chimney steel, stairways and hand rails. Gallery steel Crane bridges and steel members, Reinforcement steel.
- 4.4.2 Coarse aggregates and sand.
- 4.4.3 Un-fabricated pipes and fabricated pipe assemblies, Concrete and hume pipes. Large diameter conduits / pipes in boxes, Ash disposal pipes.
- 4.4.4 Boiler, drum, tubes, tube panels and headers.
- 4.4.5 Mill drums, bunker plates, etc.
- 4.4.6 Condenser shell parts, water boxes, etc.

- 4.4.7 Air pre-heater tube plates.
- 4.4.8 De-aerators, feed water heaters, etc.
- 4.4.9 Conveyor steel, and wagon tippler parts except drive units
- 4.4.10 Pressure vessels, reaction towers and columns, Fabricated vessels and tanks shall have their openings firmly blanked.
- 4.4.11 Flocculator Bridge, D.M. plant filters, vessels, etc.
- 4.4.12 Cable drums
- 4.4.13 Large power transformers

5.0 SPECIFIC GUIDELINES FOR STORAGE

Given below are the guidelines for certain other major equipment / materials. These are broad guidelines only and storage shall be strictly as directed by the Manufacturer / OWNER / CONSULTANT.

5.1 Condenser

Condenser shells shall be stored on sleepers in open storage. The materials shall be kept resting in such a manner that there is no distortion to the assemblies. The bracings provided at the factory shall not be disturbed. Handling shall be strictly as per the recommendations of the Manufacturer. The tube sheets shall be protected against corrosion and tube holes against scratches. The condenser tubes shall be inspected on receipt and stored in boxes in which they are reviewed.

5.2 Deaerator

The deaerator shall be drained of water and stored dry. The nozzles shall be sealed / capped. If trays are delivered separately, these shall be stored on racks in closed storage.

5.3 Feed Water Heaters, Heat Exchangers, Vessels and Bearings

- 5.3.1 These equipment shall be drained of water and stored dry, with openings and flanges sealed / capped.
- 5.3.2 The hooks, eye bolts, etc., provided shall be used for handling these equipment.
- 5.3.3 All machined surfaces shall be coated with approved protective coating at regular intervals.
- 5.3.4 Heat exchangers shall be stored in horizontal position.

5.4 Rotating Equipment such as Pumps and Compressors

- 5.4.1 These are normally stored in assembled condition in closed / semi-closed storage. When stored in semi-closed storage, they shall be covered with tarpaulin and bed plates shall rest fully on sleepers.

- 5.4.2 The CONTRACTOR is responsible for proper lubrication of these equipment as directed.
- 5.4.3 The gear boxes and oil sumps shall be kept filled with recommended lubricating gear oil. The couplings and bearings shall be covered with approved grease and nozzle flanges screwed with caps or suitably plugged.
- 5.4.4 Pumps, if delivered in dis-assembled condition, shall be stored with the parts properly greased and wrapped in paraffin paper. Smaller parts are to be stored on racks whereas larger parts on sleepers in closed storage. Occasional flushing with hot lubricating oil may have to be carried out, if so directed; in the cases of equipment such as boiler feed pump.
- 5.4.5 The shafts of rotating equipment shall be turned by 90° every week to avoid rotor journals from rusting and to ensure that shaft is free to rotate.
- 5.4.6 The CONTRACTOR shall maintain record of lubrication with details of lubricants used as well as protective measures carried out.

5.5 Piping and Valves

- 5.5.1 All pipes shall be stored on sleeper beds with open ends securely capped. The beveled ends shall be protected with a coating of approved grease. If so directed, inside surfaces of piping shall be coated with approved protective solution.
- 5.5.2 Pipes shall be neatly arranged and stacked for easy identification and retrieval.
- 5.5.3 Pipes shall be blown with air prior to installation and it shall be ensured that there is no obstruction.
- 5.5.4 Valves shall be stored with the discs screwed down on the seat so that packing surfaces are not exposed to dust. All machined surfaces shall be covered with grease. Preservation of identification tags is essential to avoid installation in a wrong service.

5.6 Switch gear & Control Panels

- 5.6.1 Depending on whether these are of indoor or outdoor design, these shall be stored in closed / semi-closed storage.
- 5.6.2 The spaced heaters, where provided, shall be kept connected with power supply irrespective of mode of storage where space heaters are not provided, use of adequate number of heating bulbs is recommended.
- 5.6.3 Insulation resistance shall be measured at regular intervals and megger values properly logged.

5.7 Transformers

- 5.7.1 It is advisable to assemble and set the transformer filled with oil in its permanent location soon after receipt even if it is not likely to be put in service for a while. In case of gas filled transformers, a positive pressure should be maintained during storage as recommended by the Manufacturer. If transformer is to be stored partially or fully dis-assembled, it shall be protected against moisture ingress / absorption by keeping them immersed in

transformer oil or as recommended by the MANUFACTURE / OWNER / CONSULTANT.

- 5.7.2 Prior to charging any transformer, it is essential to check the satisfactoriness of insulation values and di-electric strength of oil.

5.8 Cells, Accumulators, Batteries

These shall be stored in a dry and well ventilated place and protected from extreme cold. Internal parts of large cells are loose and the cells should be handled with care to avoid displacement of internals. Saw dust shall never be used for packing batteries as it is hygroscopic.

5.9 Cables

Cable drums if stored indoors shall be in dry, ventilated stores. Cables are normally supplied with ends sealed. When a length is cut, the end should be resealed. The drums shall be stored with adequate spacing between them for better air circulation.

5.10 Motors

Besides general procedures such as regular inspection and recording of insulation resistances, in the case of LT motors, if so recommended, low voltage current flow through the windings may be maintained during storage.

5.11 Instruments

- 5.11.1 These are stored on racks in closed storage and in air conditioned storage if so recommended. These shall be stored in their packages in dry condition and shall be handled with extreme care.
- 5.11.2 Instrument flanges and nozzles, if directed, shall be coated with technical Vaseline.
- 5.11.3 In the case of fragile instruments, the storage shall be in a separate zone away from where heavy materials are stored to minimise danger of damage.

5.12 STEEL

5.12.1 Reinforcement steel:

Reinforcement steel shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If stored for long periods, these may be coated with cement wash before stacking to prevent loose scales and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.12.2 Structural steel:

Structural steel could safely be stored in open storage but with sufficient space in between for handling and crane movement. All steel shall be stored 200 mm above ground on suitable packing to avoid damage. It should be stored according to sizes and sections preferably in the order required for erection. The area for open storage should be properly graded to avoid water logging in the storage area. Steel shall not be stored in the vicinity of areas where excavation or grading will be done. Scratched or abraded steel shall be given a

coat of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable coating.

5.13 Cement

- 5.13.1 Cement shall be stored in bags in a separate shed away from where mechanical and electrical equipment are stored to minimise the possibility of cement dust settling on the equipment.
- 5.13.2 The storage shed where cement is stored shall be absolutely water tight. The flooring shall be a 15 mm thick concrete slab laid on a dry course soling or as recommended. The ground shall be drained away from the shed to prevent accumulation of water in its vicinity.
- 5.13.3 The bags shall be neatly stacked with adequate passage in between for easy retrieval. The cement shall be issued on 'First-In-First-Out' basis.
- 5.13.4 In case different grades of cement are stored in the same shed, each grade shall be stacked separately to avoid mix up and clear indication boards shall be provided to identify different grades.

5.14 Synthetic Paints

These have limited life and as a safeguard against possible deterioration, the drums shall be inverted at regular intervals as specified to minimise risk of hard settling of pigments.

5.15 Slings & Wire Ropes

All slings and wire ropes shall be coated with approved grease and hung from racks in rolled condition.

6.0 DOCUMENTATION

The CONTRACTOR'S store-keeping function will include maintaining various records as required by the OWNER / CONSULTANT. These records shall include but not be limited to:

- 6.1 Supplier wise record of equipment / material received stored and issued for erection as well as stock position.
- 6.2 Record of inspection and repairs carried out, protective measures and lubrication of equipment in storage as well as erected until the same are taken over by the OWNER.



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1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
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SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

ANNEXURE XIII -GUARANTEED PERFORMANCE DATA



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
 GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IA

REV. NO. 00

S.no.	Description	Parameter
1.	Hydrogen generation plant minimum capacity (Nm3/hr.)	20
2.	Number of streams (2X50%)	2
3.	Minimum Capacity of each streams/electrolyser (Nm3/hr.)	10
4.	Hydrogen purity (%) at gas manifolds	99.998
5.	Moisture content in hydrogen- gm/m3 (max)	0.05
6.	Design delivery pressure at its rated duty point in Kg/cm2 (g)	140
7.	Max. Oxygen impurity in Hydrogen	2 ppm
8.	Dew Point	(-70)
9.	Minimum capacity of each compressor (Nm3/hr.)	125% of rated Capacity of each streams (Nm3/hr.)
10.	Vibration level of compressor	As per internationally accepted standard
11.	Noise level of compressor	85 dBA (to a reference of 0.0002 micro bar).



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

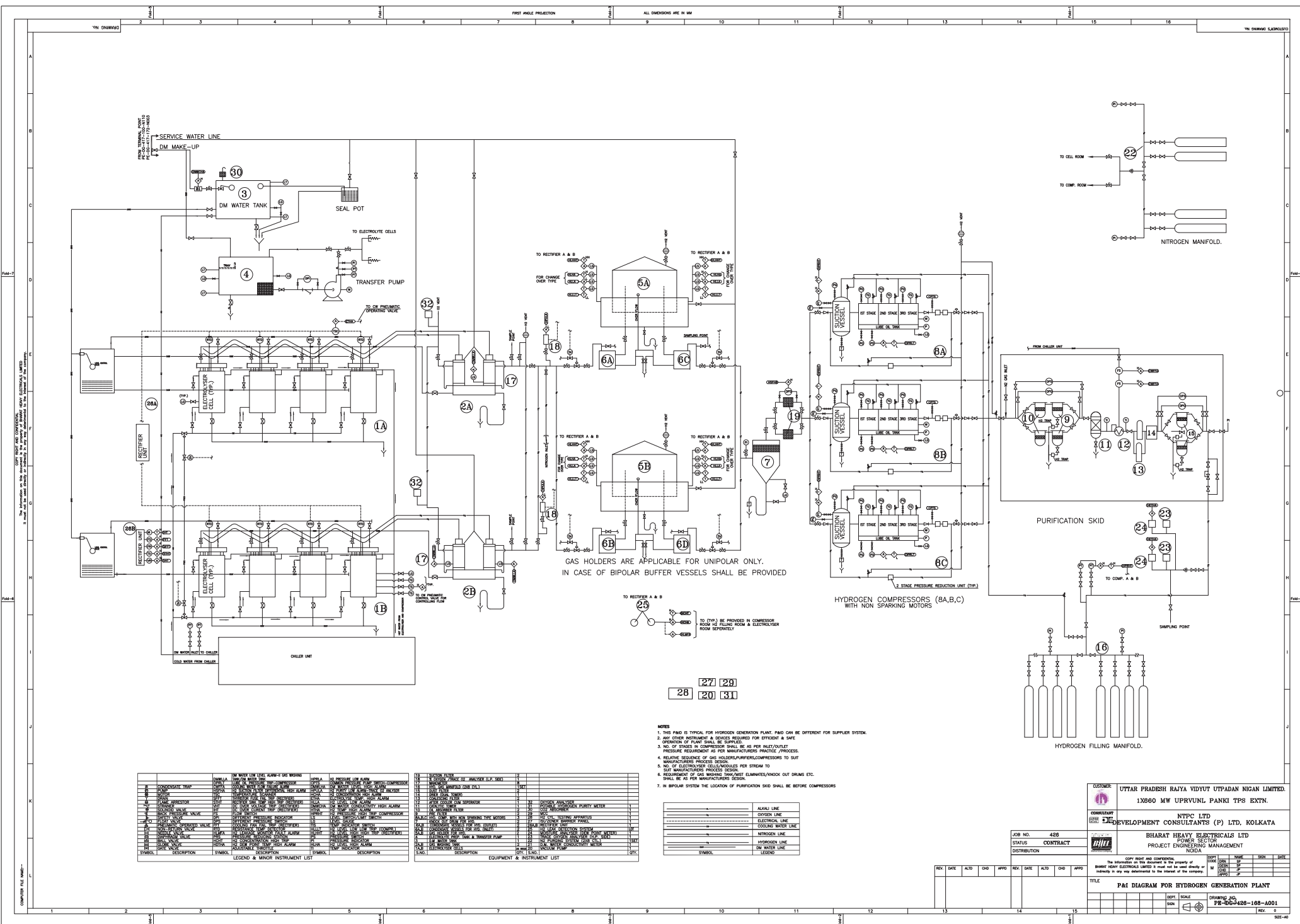
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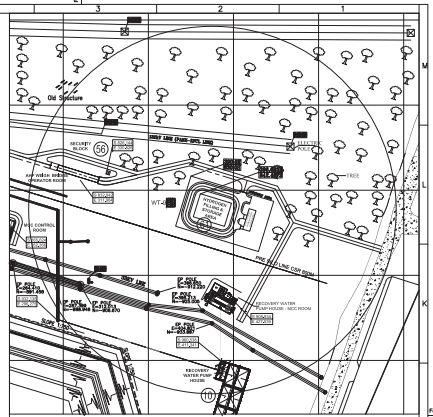
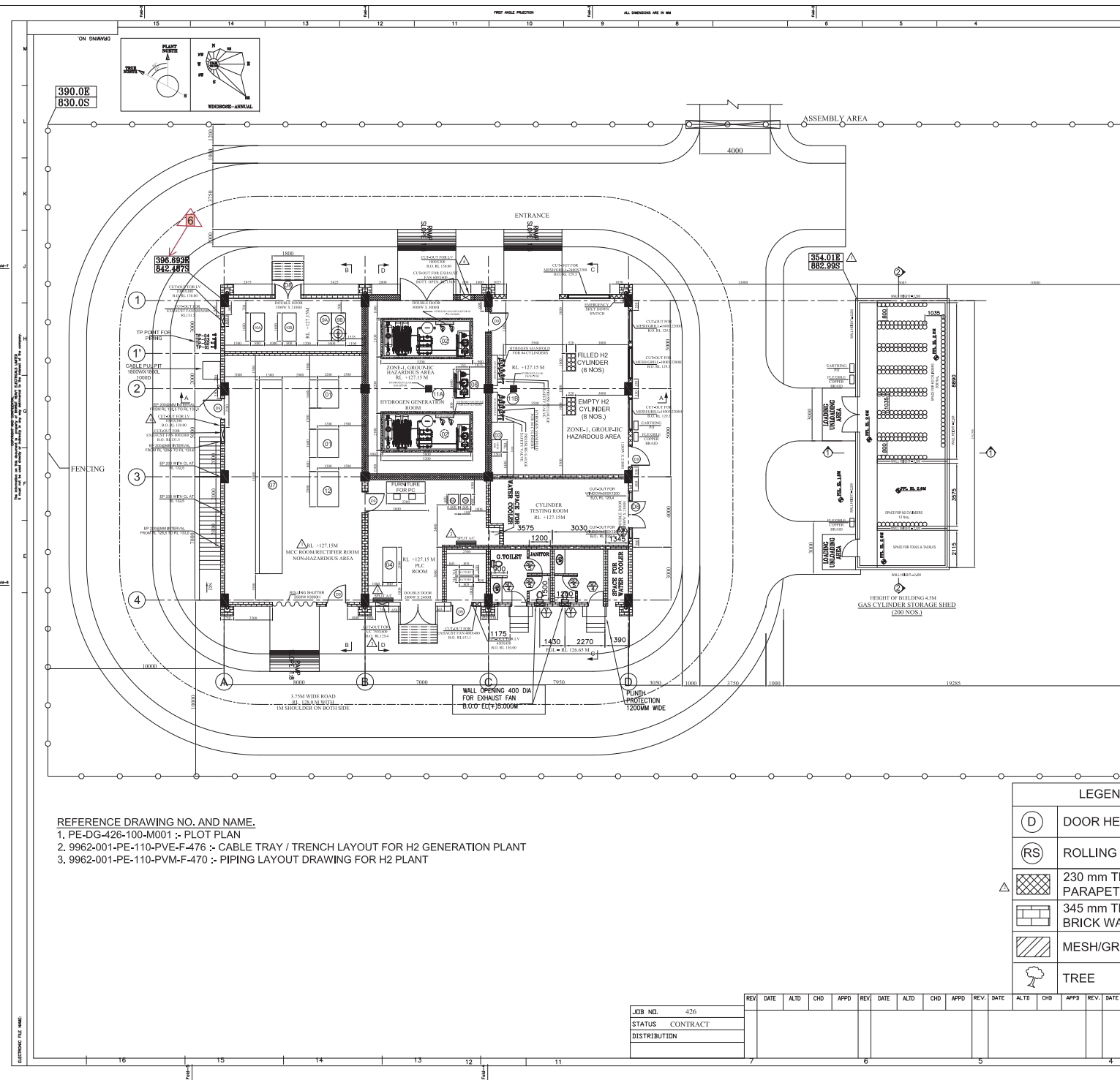
**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

P&ID AND EQUIPMENT LAYOUT





KEY PLAN

INFORMATION FOR EQUIPMENT			
Sl. No.	EQUIPMENT NAME	Load In KG (Each)	QTY.
1	RECTIFIER PANEL - AB	FOUNDATION NOT REQUIRED	2
2	ELECTROLYSER WITH GAS SEPARATION AND H2 PURIFIER, COMPRESSOR	6500	2
3	VACUUM PUMP	60	1
4	PLC PANEL	FOUNDATION NOT REQUIRED	1
5	BATTERY CHARGER (AB)	FOUNDATION NOT REQUIRED	2
6	DM WATER STORAGE TANK (ON ROOF)	FOUNDATION NOT REQUIRED	1
7	MCC PANEL (BHEL SCOPE)	-	1
8	STAND BY H2 COMPRESSOR	1000	1
9	CHILLER AB	450	2
10	INSTRUMENT AIR COMPRESSOR (AB)	400	2
11	HYDROGEN LEAK DETECTOR	-	2
12	ACN-LDB PANEL	-	1

- NOTES:**
- All dimension are in mm and levels are in meter, unless otherwise specified.
 - Gases will be discharged at height of 1m from top of building.
 - In cylinder filling & storage area, there shall be parapet wall of 230mmx800mm and after 800 mm parapet wall there will be grillmesh up to roof of the rooms.
 - All ventilation wall openings are tentative. Same shall be as per architectural drawings.
 - Inverted beams shall be considered is hydrogen generation building.
 - Columns will be inline with wall face.
 - FGL IS EL (+) 9.15M corresponds to RL = +126.65M.
 - Cable trenches not indicated in the drawing for trench details refer 9962-001-PE-110-PVE-F-476
- SAFETY NOTES:**
- Hazardous Area
 - Hydrogen generation room is monitored for the presence of hydrogen in air
 - Adequate ventilation via grillmesh and/or features is provided to prevent accumulation of H2 near the roof
 - Instrument in this area shall be explosion/flammeproof
 - Non-Hazardous Area - Hazardous material is not handled in this area
 - Separation of this area from other area is via walls
 - Use appropriate safety measures in handling hazardous material/ equipment refer operational, manual.

NTPC DRG. No. :- 9962-001-PE-110-PVM-F-468

PROJECT: 1 X 660MW PANKI THERMAL POWER EXTENSION PROJECT.

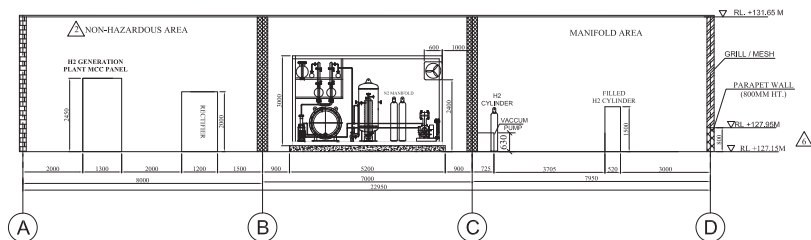
OWNER:	UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD.
REVIEW CONSULTANT:	NTPC LTD. (A GOVERNMENT OF INDIA ENTERPRISE)
CONSULTANT:	DEVELOPMENT CONSULTANTS PVT. LTD. KOLKATA
SUB CONTRACTOR:	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA
	AIROX NIGEN EQUIPMENTS PVT. LTD.

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DEPT.	SCALED NTS	DRAWING NO.	DATE
SIGN		PE-V-0-434-168-A017	30/06/22
		SHEET 01 OF 02	REV. 06

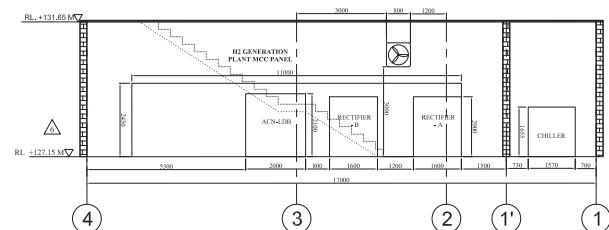
JOB NO.	426	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD
STATUS	CONTRACT															
DISTRIBUTION																

- REFERENCE DRAWING NO. AND NAME.**
- PE-DG-426-100-M001 :- PLOT PLAN
 - 9962-001-PE-110-PVE-F-476 :- CABLE TRAY / TRENCH LAYOUT FOR H2 GENERATION PLANT
 - 9962-001-PE-110-PVM-F-470 :- PIPING LAYOUT DRAWING FOR H2 PLANT

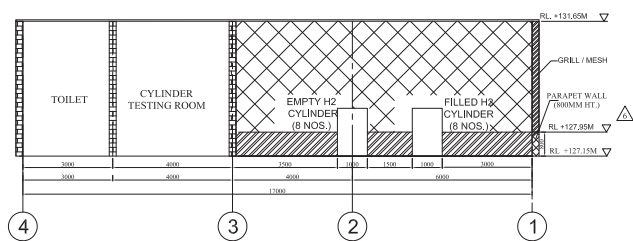
LEGEND	
(D)	DOOR HERE
(RS)	ROLLING SHUTTER
(X)	230 mm THK. PARAPET WALL
(B)	345 mm THK. BRICK WALL
(M)	MESH/GRILL
(T)	TREE



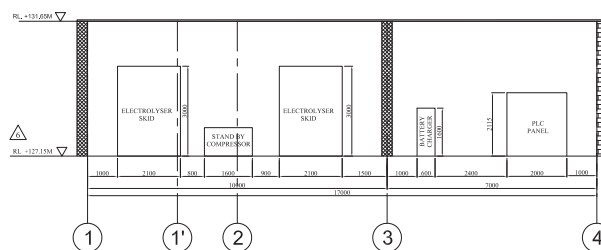
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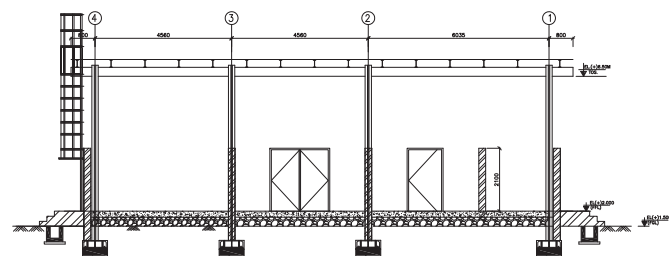
SECTION : B-B



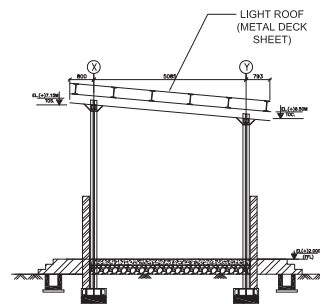
SECTION : C-C



SECTION : D-D



SECTION 2-2



SECTION 1-1

NTPC DRG. No.: - 9962-001-PE-110-PVM-F-468

PROJECT: 1 X 660MW PANKI THERMAL POWER EXTENSION PROJECT.

OWNER: UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD.

REVIEW CONSULTANT: NTPC LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)

CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD.
KOLKATA

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

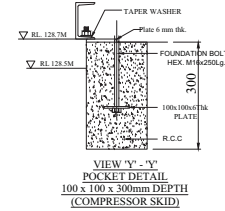
SUB CONTRACTOR: AIROX NIGEN EQUIPMENTS PVT. LTD.

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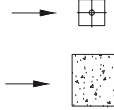
TITLE: GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS OF
HYDROGEN GENERATION PLANT

DEPT. SCALED NTS: DRAWING NO. DRAWING NO.
SHEET 02 OF 02 REV. 06

SIZE-A1



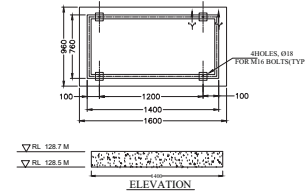
TYP-A
"SYMBOL"
POCKET



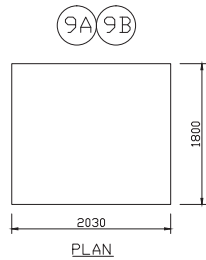
RCC WORK

NOTES:-

- 1) ALL ELECTRICAL PANEL SHALL BE MOUNTED ON
CABLE TRENCH CIVIL FOUNDATION NOT REQUIRED
FOR PANELS.
2) FOUNDATION POCKET NOT REQUIRED FOR
VACUUM PUMP.

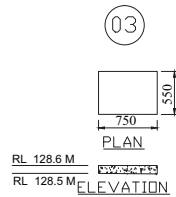


⑤
FOUNDATION FOR H2
COMPRESSOR SKID

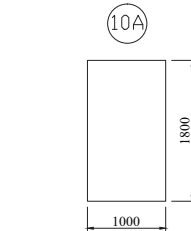


RL 128.6 M
RL 128.5 M
ELEVATION

PEDESTAL FOR CHILLER
UNIT



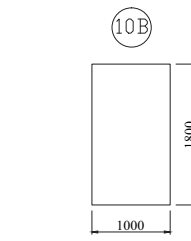
PEDESTAL FOR VACCUM
PUMP



RL 128.6 M
RL 128.5 M

1000

PEDESTAL FOR
INSTRUMENT AIR
COMPRESSOR



PEDESTAL FOR
INSTRUMENT AIR
COMPRESSOR

NTPC DRG. No.: - 9962-001-PE-110-PVM-F-468

PROJECT:	1 X 660MW PANKI THERMAL POWER EXTENSION PROJECT.

OWNER:	UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD.

REVIEW
CONSULTANT:
 NTPC LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)

CONSULTANT:
 DEVELOPMENT CONSULTANTS PVT. LTD.
KOLKATA

	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA


AIROX NIGEN EQUIPMENTS PVT. LTD.

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		DRN	GR		
		DESN	G.R		
		CHD	JM		
		APPD	AKA		

TITLE	GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS OF HYDROGEN GENERATION PLANT		

DEPT.	SCALE: NTS	DRAWING NO.	DRAWING NO.
SIGN			PE-V0-434-168-A017
3			SHEET 04 OF 04 REV. 00

DATASHEET OF GAS DRYER SKID

Catalyst Column		
Description	:	Specification
Operating Pressure	:	10 Bar (G)
Design Pressure	:	11 Bar (G)
Operating Temperature	:	150°C
Design Temperature	:	200°C
Pressure vessel design code	:	ASME Sec VIII
Type of deoxidizer unit	:	Palladium Deoxo
No. of deoxidizer unit	:	1 for each stream
Inlet H2 Capacity for deoxidizer	:	11 Nm3/hr
Absorber Bed MOC	:	SS304
Body MOC	:	ASME SA312 TP304
Tag & Kks Tag	:	401/501(10MKG01AT108/10MKG02AT108)
No.	:	

Description	Specification
H ₂ Capacity Nm3/hr.	11 (Ex Electrolyser)
O ₂ Capacity Nm3/hr.	5.5 (Ex Electrolyser)
DM Water Consumption	10 Ltr per stream
Electrolyte (KOH%)	30% KOH (by Volume)
Operating Temperature	65°C-85°C
Design Temperature	110°C
Working Pressure	10 bar (g)
Design Pressure	11 bar (g)
No. of module	1 per stream
A.C. Power Consumption	5.5 KWH/m3 of raw H ₂
MOC of cell end plate (Cover)	Nickel Plated CS
Electrode material	
a. Cathode	Nickel
b. Anode	Activated Nickel
Diaphragm Material	Membrane Cloth
Turn Down Ratio	20% to 100%
Cooling Water Requirement	6m3/Hr. circulating for each stream
Gas Separation skid consist of	Electrolyser, Hydrogen Gas Separator, Hydrogen Gas Cooler & Moisture Separator, Dm Feed Water Tank Cum Lye Making Tank, Dm Feed Pump, Electrolyte Strainer, Cooler, Pump, Oxygen Gas Separator, Oxygen Gas Cooler & Moisture Separator, Interconnected Piping, Associated Instrument, Moisture Drain, Isolation Valves As Per Our PID.
MOC of H ₂ /O ₂ Separators	ASME SA 312 TP304
MOC of lye cooler	ASME SA 312 TP304
MOC of lye filter	ASME SA 312 TP304
H ₂ gas cooler & moisture gas separator	ASME SA 312 TP304
O ₂ gas cooler & moisture gas separator	ASME SA 312 TP304
Gas condenser	ASME SA 312 TP304
O ₂ & H ₂ demister	ASME SA 312 TP304

DATASHEET OF LYE CIRCULATION PUMP

Description	Specification
No. of pumps	1 per stream
Capacity CuM/Hr	09
Tag & Kks Tag No.	P211/311 (10MKG01AP101 / 10MKG02AP102)
MOC	
Rear Casing	SS316
Impeller	SS316
Shaft Sleeve	Silicon Carbide
Shaft	SS316
Gasket	Teflon

LYE CIRCULATION MOTOR

Rated Nameplate Rating, KW	:	0.75 KW
Rated Voltage, Phase and Frequency	:	415/3/50Hz
Rated Speed	:	2900

DATASHEET OF DM FEED WATER CUM LYE PUMP

Description	:	Specification
Rating	:	1.1 KW
Capacity	:	80LPH
Tag & Kks Tag No.	:	P710/720 (10MKG01AP104 /
MOC	:	10MKG02AP104)
Shaft	:	SS 316
Piston	:	SS 316

DM FEED WATER CUM LYE PUMP MOTOR

Rated name Plate Rating	:	1.1 KW
Rated Voltage, Phase and Frequency	:	415 V± 10 % ,3PH,50Hz
Synchronous Speed	:	1440 RPM

DATASHEET OF DM WATER CUM LYE MAKING TANK

Description	:	Specification
No. of Tank	:	1 Nos. (per stream)
MOC of tank	:	SS304
Size of tank	:	200Ltr.
Tag & Ks Tag No.	:	V701/702 (10MKG01BB104/ 10MKG02BB104)

DATA SHEET OF BUFFER TANK

QTY.	:	2 NO. (ONE FOR PER STREAM)
Working pressure	:	10 Bar (g)
Design pressure	:	11 Bar (g)
Capacity	:	400 LTR.
Design code	:	ASME SEC VIII DIV 1
Test pressure	:	16.5 Bar (g) 
MOC of tank	:	SA 516 GR 70

426	
STATUS	CONTRACT
DISTRIBUTION	

NTPC DRG. No.:- 9962-001-P2-110-PVM-Y-453	
PROJECT:	1 X 660MW PANKI THERMAL POWER EXTENSION PROJECT.
OWNER:	UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD.
REVIEW CONSULTANT:	NTPC LTD. (A GOVERNMENT OF INDIA ENTERPRISE)
CONSULTANT:	DEVELOPMENT CONSULTANTS PVT. LTD. KOLKATA
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT Noida
SUB CONTRACTOR:	AIROX NIGEN EQUIPMENTS PVT. LTD.

COPY RIGHT AND CONFIDENTIAL		NAME	SIGN	DATE
DRN	GR			23.11.20
DESN	G.R			23.11.20
CHD	JM			23.11.20
ADDP	AN/A			23.11.20

TITLE	GA and Datasheet of Electrolyser and purification skid

DEPT.	SCALE: NTS	DRAWING NO.	DRAWING NO. 18	
SIGN			PE-V0-434-168-A002	
3			SHEET 03 OF 04	REV. 03



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION:IB

REV. NO. 00

SUB-SECTION IB - SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

	TITLE : ELECTRICAL EQUIPMENT SPECIFICATION FOR HYDROGEN GENERATION PLANT 1X660 MW UPRVUNL PANKI TPS	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION :
		REV NO. 00 : DATE : 31.05.19
		SHEET : 2 OF 3

1.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:**

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for **HYDROGEN GENERATION PLANT**.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “ both end equipment in vendor’s scope”shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

2.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:**

Refer “Electrical Scope between BHEL and Vendor”.

3.0 **DOCUMENTS TO BE SUBMITTED ALONG WITH BID**

- 3.1 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

	TITLE : ELECTRICAL EQUIPMENT SPECIFICATION FOR HYDROGEN GENERATION PLANT 1X660 MW UPRVUNL PANKI TPS	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION :
		REV NO. 00 : DATE : 31.05.19
		SHEET : 3 OF 3

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
- b) Quality plan for motors
- c) Datasheet A (Annexure- I)
- d) Customer (M/s DCPL) specification for Motors
- e) Datasheet-C
- f) Electrical Load data format (Annexure –II)
- g) BHEL cable listing format (Annexure –III)
- h) Mandatory spares List



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION:IB

REV. NO. 00

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)**PACKAGE: HYDROGEN GENERATION PLANT****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT:**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)**PACKAGE: HYDROGEN GENERATION PLANT****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT:**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL. Vendor to ensure the cable tray lay out shall confirm to NFPA (National fire prevention act)/TAC (Tariff advisory committee) applicable for hazardous area classification.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: HYDROGEN GENERATION PLANT

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

PROJECT:

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.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION:IB

REV. NO. 00

ELECTRICAL LOAD DATA FORMAT

LOAD TITLE	RATING		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. (Y)	CONT.(C)/INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE (KW)	MAX. CONT. DEMAND (MCR) (AMP.)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
STREAM 1																		
Rectifier	55	96	S	1		D	S	N	C		INDOOR			1				
H2 Compressor	5.5	10	S	1		D	U	N	C		INDOOR			1				
DM Water cum lye Pump	1.1	2	S	1		D	U	N	I		INDOOR			1				
Lye Circulation Pump	1.1	2	S	1		D	U	N	C		INDOOR			1				
Heater (Catalyst Column)	2	11	S	1		E	S	N	C		INDOOR			1				
Dryer Heater	2	11	S	1		E	S	N	C		INDOOR			1				
Dryer Heater	2	11	S	1		E	S	N	C		INDOOR			1				
STREAM 2																		
Rectifier	55	96	S	1		D	S	N	C		INDOOR			1				
H2 Compressor	5.5	10	S	1		D	U	N	C		INDOOR			1				
DM Water cum lye Pump	1.1	2	S	1		D	U	N	I		INDOOR			1				
Lye Circulation Pump	1.1	2	S	1		D	U	N	C		INDOOR			1				
Heater (Catalyst Column)	2	11	S	1		E	S	N	C		INDOOR			1				
Dryer Heater	2	11	S	1		E	S	N	C		INDOOR			1				
Dryer Heater	2	11	S	1		E	S	N	C		INDOOR			1				
COMMON																		
Vacuum Pump	1.11	2	S	1		D	U	N	I		INDOOR			1				
Battery charger-1	5	9	S	1		D	S	N	C		INDOOR			1				
Battery charger-2	5	9	S	1		D	S	N	C		INDOOR			1				
Cylinder Testing Apparatus																		
a) Heater	2	11	S	1		E	S	N	I		INDOOR			1				
b) Pump	3.7	7	S	1		D	U	N	I		INDOOR			1				
c) Blower	2	4	S	1		D	S	N	I		INDOOR			1				
Exhaust Fan 1	1.5	3	S	1		D	S	N	C		INDOOR			1				
Exhaust Fan 2	1.5	3	S	1		D	S	N	C		INDOOR			1				
Exhaust Fan 3	1.5	3	S	1		D	S	N	C		INDOOR			1				
Exhaust Fan 4	1	6	S	1		E	S	N	C		INDOOR			1				
Exhaust Fan 5	1	6	S	1		E	S	N	C		INDOOR			1				
Exhaust Fan 6	1	6	S	1		E	S	N	C		INDOOR			1				
AC 1	--	32	S	1		E	S	N	C		INDOOR			1				
AC 2	--	32	S	1		E	S	N	C		INDOOR			1				
Chiller (W)	5	9	S	1		D	S	N	C		INDOOR			1				
Chiller (S)	5	9	S		1	D	S	N	C		INDOOR			1				
Instrument air compressor(W)	5	9	S	1		D	U	N	C		INDOOR			1				
Instrument air compressor(S)	5	9	S		1	D	U	N	C		INDOOR			1				
H2 COMPRESSOR(S)	5.5	10	S		1	D	U	N	C		INDOOR			1				
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) 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 (CONTACTOR CONTROLLED)																		
LOAD DATA (ELECTRICAL)	JOB NO.		9962-001-PE-110-PVE-H-471									ORIGINATING AGENCY		PEM (ELECTRICAL)				
	PROJECT TITLE		1 X 660 MW PANAKI TPP									NAME		DATA FILLED UP ON				
	SYSTEM / S		H2 GEN. PLANT									SIGN.		DATA ENTERED ON				
	DEPTT. / SECTION		ELECTRICAL									SHEET 1 OF 1		REV 04		DE'S SIGN. & DATE		



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION:IB

REV. NO. 00

CABLE SCHEDULE FORMAT



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION:IC

REV. NO. 00

SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
Specific Technical Requirements (C&I): 1. The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire Hydrogen Generation 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. Hydrogen Generation Plant shall be PLC based system having 1 working+1 hot standby CPU. Redundancy should be ensured minimum at CPU, communication system & power supply level. PLC control system as defined in the enclosed specs and DATA Sheets shall be in bidder's scope. The PLC system shall comprise of (i) PLC based local panel (ii) UPS Power supply (iii) Operator interface in the form of CRT, keyboard and OWS along with required furniture. Above stated items are in bidder's scope of supply. 3. 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. 4. 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. 5. Supplied system shall provide group alarms to be hardwired to plant DCS. 6. The 24 V DC systems shall consist of 2 sets of power supply with each set consisting of 1 x 100% battery charger, 1 x 100% batteries for 1-hour duty and 1 x 100% DC distribution board. 7. Intelligent Battery health management system shall be provided for each set of 24VDC power supply system and UPS batteries (except mini-UPS). It shall be connected to DCS. 8. All battery systems shall be provided with a manual discharge resistance bank. 9. 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		

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
position of backrest. One table and chair shall be provided for each operator station and separate table for each printer. 10. The complete hydrogen generation plant system, equipment, layout shall be designed as per the guidelines of explosive authority and other statutory authorities for the design and installation of the plant. All transmitters & electronics items including JB's will be explosion proof / intrinsically safe as per hazardous area classification. 11. All instrument devices shall be provided with explosion proof enclosure as described in NEC (USA) Article 500, Class-I, Div. I or provided with suitable type Zener barriers of standard approved make meeting the requirements as approved by chief controller of explosives and statutory authorities. 12. The scope of C&I cable shall be referred in Electrical scope split sheet in Electrical portion of the specification. 13. All instruments shall be protected by cases. The cases shall have enclosure classification not less than IP 42 according to EN 60529 when mounted indoors in totally enclosed rooms with provision for limited ingress of dust, IP 54 else in an enclosed building and IP 55W for mounting outdoors. 14. Bidder's presence is required for 5 Man days at site during commissioning of PLC for assistance related to process correctness. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope. 15. All KKS tag nos. shall have prefix 10. 16. The quantity of instruments for the system shall be as per tender P & ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments & items are required for safe & reliable operation of plant, bidder shall supply the same without any price implication. Instrument installation and required accessories shall be in bidder's scope. 17. Redundancy of sensors shall be provided, irrespective of instrumentation shown in the PID, by bidder as per sheet attached in the specification. (ANNEXURE 1)		

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
18. Contractor's C&I representative shall be present at BHEL-PEM for 3 man-days, for preparation of Control scheme of DM Plant. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope. 19. Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder. 20. For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification. 21. Bidder shall provide Cable Schedule in BHEL excel format which shall be provided during detailed engineering. Also, Cable Interconnections for Complete System shall be in Bidders' scope. DCS side details for hardwired signals shall be furnished by BHEL during detailed engineering. 22. Interface of control panel, field instruments, actuators etc. with DCS based control system shall be as per Drive Control Philosophy enclosed in Section-D. 23. Electrical Actuators with integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable, typical Hook-up diagram of drives is included for reference. 24. MOVs (Motorized Valves) shall be integral type, if applicable. 25. Bidder to furnish electrical load/UPS load data during detailed engineering. 26. Non-UPS 240 V AC (supply feeder)/415 V, 3 phase, 4 wire AC supply shall be provided by BHEL based on the load data provided by the bidder at contract stage for all equipment supplied by the bidder as part of contract. Any other voltage level (AC/DC) required will be derived by the bidder. Bidder to include necessary power distribution board in his scope and all necessary hardware/software for the same shall be in bidder's scope. 27. Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only.		

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
28. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only. 29. Bidder shall provide starter panel for local start/ stop monitoring of auxiliaries and equipment along with status indications and alarms as per requirement. The requirement shall be decided during detailed engineering. 30. Local push buttons in the field shall be in Vendor's scope. 31. Local control panel if any required for operation shall be in bidder scope. 32. Bidder to supply all the instruments (PT, LT, DPG, LG and DPS etc.) required for the package along with necessary fittings, accessories and valve manifold etc. All instruments shall be provided with durable epoxy coating for housing and all exposed surfaces of the instruments. Instrument Installation along with hardware shall be in bidder scope. Double root valves shall be provided where pressure is above 40 Kg/cm². 33. All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART). Each Temperature element shall be complemented with temperature transmitters, compensating cable, JB/rack & other erection hardware. All transmitters shall be fitted with a local analog/digital indicator displaying appropriate physical units which may be read clearly from an easily accessible position. 34. Use of process actuated switches shall be avoided unless Unavoidable. 35. All instruments and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. 36. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering. 37. DP instruments with minimum Capillary length of 15m is to be supplied. 38. All Temperature sensors shall be Duplex type and temperature transmitter shall be provided for all temperature measurement applications.		

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
39. All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless otherwise specified. 40. All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack so that the equipments are protected against rain/ sunlight etc. 41. The junction boxes/LIEs for termination of instruments are in bidder's scope. 42. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial/ time implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with. 43. The make of all the items shall be from approved sub-vendor list. 44. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured. 45. All Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable. 46. 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. 47. 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. 48. 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. 49. Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no Instruments/ analysers & JB's/Racks should be protruding on the walkway. 50. All field instruments shall be terminated on Junction box/Local control panel in field. All the instruments along with necessary fittings, accessories and valve manifold etc., erection hardware including racks, junction boxes,		

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
canopies, structural steel, LIE, LIR, actuator limit switches etc.as required shall be in vendor's scope of supply. 51. Bidder to provide erection hardware including canopies, structural steel as required. 52. Bidder to perform tests of C&I items/instruments/systems as per quality plans/type test attached in the specification. 53. 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. 54. 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. 55. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured. 56. Mandatory spares have to be supplied by bidder as mentioned in the specification. 57. 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. 58. The specifications for instruments mentioned in the specification are minimum requirements. Datasheets of instrument shall be subject to customer/owner approval. 59. All approval/Inspection are to be carried out by Owner or owner appointed agency only. 60. Drawings/Documents and data to be furnished after award of the contract shall be in line with MDL furnished elsewhere in the specification. 61. Mandatory spare list as per 'List of mandatory spares' attached elsewhere in the specification is in vendor's scope.		

	1X660MW PANKI TPS EXTN.	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) HYDROGEN GENERATION PLANT	
62. Editable & pdf copy of Drawings/Documents and data to be furnished after award of the contract: • GA & wiring diagram of local panel. • Local control panel & instruments data sheet. • Any other document decided during detailed engineering. Note: - 1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage. 2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL. 3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication. 4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met. 5. In case of any discrepancy in Section-C and Section-D of the specification, Section-C shall prevail.		

ANNEXURE - 1**(g) Redundancy requirements****i Triple Redundancy**

Triple Sensing device shall be provided for following applications:-

- a. **For** Binary and analog inputs required for protection of boiler, turbine and major auxiliaries of main plant whose non-availability may result in 50% loss of unit availability and loss of generation.
- b. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for important auxiliaries and HT Drives of main plant (fed by a supply feeder of ratings 3.3 kV onwards)/MDBP/TDBFP etc.,
- c. Separate triple sensors for Instruments required for auto starting of HT driven pumps or HT driven pump tripping due to very low level of water & discharge pressure very low.
- d. For binary and analog inputs which are also required for protection in addition to CLCS. The same shall include but not limited to the critical measurement used for following CLCS :-
Furnace draft, main steam and reheat steam temperatures, feed-water flow, throttle pressure, turbine first stage pressure, separator level, LPH and HPH level, deaerator level, hotwell level, CEP minimum recirculation, BFP minimum recirculation etc.
- e. For lube oil protection of all the HT drives, 2 out of 3 logics and necessary pressure transmitters for lube oil pressure shall be provided by bidder accordingly. However for bearing / winding temperature of HT motor, refer Electrical subsections, Vol. IV.
- f. Left and right side shall be treated as individual path / individual parameter, and each side/path shall have own triple redundancy accordingly.

ii Dual Redundancy

Dual Sensing device shall be provided for following applications:

- a. For binary and analog inputs required for all other closed loop control system (CLCS), protection and interlock conditions purpose of other equipments.
- b. For Instruments required for auto starting of LT driven pumps or LT driven pump tripping due to very low level of water/discharge pressure very low.
- c. Dual redundant position transmitters shall be provided for Steam Admission Valves i.e. (Emergency Stop & Control Valves, Reheat Stop Valves & Control valves), Extraction steam QCNRV, CRH NRV.
- d. For instruments required for Heat rate measurements & PADO calculations.

- iii. For binary and analog inputs used for alarm and monitoring only, single sensor criteria shall be applicable.

BILL OF MATERIALS			
SL. NO.	ITEM	SPECIFICATION	TOTAL QTY.
PLC Accessories			
1	NP1B5-11D	Base Board 11 Slot, Processor Bus 4 slot	2
2	NP1BP-13D	Hot plug baseboard with station No. setting switch for 13 slot	1
3	NP2L-BH1	5X Bus duplex connection unit	3
4	NP1S-42	24V DC Redundant power supply output : 35W	6
5	NP1PS-32R	32K steps - Max. No. of I/O points: 8192 points (SPH300)	2
6	NP1X3206-W	24 V DC, 32 points, 4mA , 1 to 100ms variable connector type- 2	2
7	NP1Y32U09P1	Tr. Source 12 to 24V DC, 32 point, 0.12 A/point, 3.2 A/ common	3
8	NP1AXH8-MR	Multi range, high speed type, Current input : 9	9
9	NP31-ET1	Ethernet interface Module 10 BASE-T/ 100 BASE-TX	4
10	FEI/Accessories	40 Pin FCN connector with cable 3M	1 LOT
11	FEI/Accessories	8X Bus Cable	1 LOT
12	FEI/Accessories	Ethernet Cable	1 LOT
13	FEI/Accessories	24" Workstation for OEWS	2
14	FEI/Accessories	A4 Colour Laser Printer	1
15	FEI/Accessories	8/W dot matrix Printer	1 LOT
16	FEI/Accessories	16 Ch Relay board for DI	1 LOT
17	FEI/Accessories	16 Ch Relay board for DO	1
18	FEI/Accessories	PLC Panel Cabinet	1
19	FEI/Accessories	Ethernet Switch	As Req.
20	FEI/Accessories	24V DC Power Supply	As Req.
21	FEI/Accessories	Ethernet Switch	2
22	FEI/Accessories	24V DC Power Supply	2
SOFTWARE			
23	Tellus Compact USB KEY	License for SCADA runtime	2
24	Tellus Reporter	Reporting Package for Tellus	2
25	VSFT 6.0	SCADA Development Software	1
26	NP4H-SEDBV3	Programming Support Tool Expert (D300 win) software package	1
Misc			
27	Packing		1 LOT
28	Transportation F.O.R. Bhiwandi		1 LOT
Services			
29	Engineering and Software Development		1 LOT
30	Site commissioning 21 days		1 LOT
31	Travel, Boarding & Lodging		1 LOT

SIGNALS	REQUIRED I/Os	INCLUDING 20% SPARE	CHANNEL DENSITY	NO. OF MODULE	OFFERED I/O
Digital Input	47	57	32	02	64
Digital Output	77	93	32	03	96
Analog Input	57	69	08	09	72
NOTE:	20% SPARE I/O have been considered. 10% Spare Slots shall be provided in each rack.				

SYSTEM ARCHITECTURE					PAGE DESCRIPTION				DOC TITLE	SYSTEM ARCHITECTURE			
									PROJECT	PLC+SCADA FOR 1X660 MW PANKI TPS			
REV								CUSTOMER	BHEL			FUJI ELECTRIC INDIA PRIVATE LIMITED	
REV												DOC. NO.: FEI/BHEL-P/-SA	
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FUJI ELECTRIC INDIA PRIVATE LIMITED

DOC. NO.: FEI/BHEL-P/-SA

SHEET: 02 OF 02 139



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IIA

REV. NO. 00

GENERAL TECHNICAL REQUIREMENT



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION: IIA

REV. NO. 00

SECTION – IIA

GENERAL TECHNICAL REQUIREMENT (MECHANICAL)

36.0 HYDROGEN GENERATION PLANT**36.1 SYSTEM DESCRIPTION**

36.1.1 The purpose of H₂ Generation Plant shall be generation of dry compressed H₂ gas, which will be required for initial filling as well as replenishing the loss that shall occur from the hydrogen cooled turbo generators. Hydrogen will be produced by electrolysis of water. Electrolyzer will be of medium pressure bipolar /unipolar sealed compact design, based on self circulating principle, consisting of two (2) nos. 50% capacity streams of net rated capacity 10 NM³/hr (minimum) for each stream. However, the net rated capacity for hydrogen generation plant shall be finalized by the EPC contractor as per the guidelines indicated in clause no. 36.3.

In eletrolyzer cell, due to electrolysis of suitable mixture of dematerialized water (tapped off from DM water transfer pump discharge pipe) and KOH solution, hydrogen gas will be generated at one electrode (cathode) and oxygen gas at the other electrode (anode). Both the gases thus generated shall be made to pass through gas scrubber / washer to separate out electrolyte from the gas. After gas scrubbing and electrolyte separation, Oxygen shall be vented to atmosphere to the extent of meeting pollution regulations in force while hydrogen shall undergo further purification to achieve required purity (as indicated elsewhere in this specification) before getting compressed for onward filling of cylinders.

In general Hydrogen Generation Plant shall comprise of following equipment:

- a) Alkaline Electrolyzer Cell(s) complete with electrolyte preparation system.
- b) Gas washer /scrubber and electrolyte separation/recovery system.
- c) Hydrogen gas purification system.
- d) Hydrogen gas compression system.
- e) Compressed dry and purified Hydrogen gas filling station / system to cylinders.
- f) Provision for online filling arrangement of dry & purified hydrogen to the cooling system of turbo generator.

36.1.2 Adequate Nitrogen cylinder racks complete with piping network shall be provided for purging and scavenging of the entire hydrogen gas stream. Also, for gas cooling, if chilled water is required, package chiller unit of suitable capacity shall be provided.

36.2 CODES AND STANDARDS

36.2.1 The design, manufacture, testing and performance of Hydrogen Generation Plant and its associated equipments, piping, valves and accessories, shall comply with the requirements of one or more of the following codes as applicable:

IS-2825	:	Code for unfired pressure vessels.
IS-4503	:	Shell and Tube Type Heat Exchanger.

CAGI	:	Compressed air and gas institute
NFPA-50A-1984	:	Standard for gaseous Hydrogen Systems at Consumer Sites.
IS-1239 [Part-I & II]	:	Mild Steel tube and fittings.
IS-5727	:	Glossary of terms relating to compressors and exhausters.
ANSI-B16.5	:	Steel Pipes Flanges and Fittings.
IS-7938	:	Air Receivers for Compressed Air Installations.
BS-5169	:	Fusion Welded Steel Air Receiver.
IS-10431 [Part-I]	:	Measurement of Air Flow of Compressors and Exhausters.
IS-4736	:	Hot dip zinc coating for steel tubes.
IS-11780	:	Code for selection and testing of rotary screw air compressors.
IS-14875	:	Compressed air filters – evaluation parameters.
IS-11727	:	Measurement and evaluation of vibration severity in situ of large rotating machines with speed ranging from 10 to 200 rev /sec.
IS-5456	:	Code of Practice for testing of positive displacement type air compressors and exhausters.
ASME PTC-9	:	Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers.
IS 7285	:	Specification for seamless steel cylinders for permanent and high pressure liquefiable gases.
IS 3224	:	Valve fittings for compressed gas cylinders excluding Liquefied Petroleum Gas (LPG) cylinders.
IS 2148	:	Electrical apparatus for explosive gas atmosphere- Flameproof enclosures “d”.

Standard of TEMA.

International Standards like American/BS/DIN etc. equivalent or superior to above mentioned standards are acceptable. When IS specification is not available the equipment shall conform to one such International Standard, which shall be indicated in the proposal.

36.3 GENERAL PLANT DESIGN CRITERIA & PERFORMANCE REQUIREMENT

- (a) To be designed for continuous, as well for two shift or one shift operation.
- (b) The scheme shall be based on manufacturer's standard. Hydrogen generation plant offered can either be of unipolar design or bipolar design as per manufacturer's standard practice.
- (c) Total Plant Capacity to be sized by EPC Contractor as follows:

Leakage rate per generator = "A" NM³/day

Margin on leakage rate = 50% (As per good engineering & industry practice)

Required volume of hydrogen for one generator filling = "B" NM³.
(Generator filling is envisaged once in a year. It is considered that this volume of hydrogen would be produced in maximum 30 days time. Subsequently this volume of hydrogen can be stored in a few cylinders).

Number of Units or Generators in plant = C

Hydrogen generation plant operating hours considered per day = T hours (EPC contractor to provide data)

Hydrogen generation plant Capacity = $[C \times 1.5 \times A + B/30] / T$ NM³/hr

- (d) The Plant capacity would be based on the Criteria detailed out above. However, total plant capacity in no case shall be less than 20 NM³/hr with two (2) nos. streams of 50% capacity each with minimum capacity of 10 NM³/hr of dry hydrogen gas continuously at the bottle filling manifold and the same shall be pressurized to 140 Kg/cm² (gauge). No negative tolerance on delivered capacity is accepted.
- e) Hydrogen purity to be maintained at the outlet of dryer / gas manifolds 99.998% (minimum)
- f) Moisture content in hydrogen: 0.05 gm/m³ (max.)
- g) Max. Oxygen impurity in Hydrogen: 2 ppm
- h) Dew Point (-) 70 deg. C
- i) The Complete Hydrogen generation plant system, equipments, layout etc. shall be designed as per the Explosives Authority and the bidder shall obtain the approval from Chief controller of Explosives - India and other statutory authorities for the design and installation of the plant.
- j) Description of various components of Hydrogen generation plant has been discussed below. Some of the components specified herein may not be applicable for bipolar design. For bipolar design, the same need not be supplied, if it is not applicable as per manufacturer's standard practice.

- k) Capacity of hydrogen generator shall be adjustable between 20% to 100% of rated value without any deterioration of hydrogen quality as stipulated above. The Plant shall be designed to operate on part load.
- l) The noise level inside the plant (at any point but within a distance of 1.0 meter from any equipment surface) shall not exceed 85 dba corresponding to overall sound pressure level reference of 20 micropascal. Equipment shall be designed for safe operation without excessive vibration.
- m) The oxygen gas generated, as a byproduct shall be freed from pollutants and vented to the atmosphere after meeting environmental regulations.

36.4 GENERAL OPERATIONAL CRITERIA / PHILOSOPHY

- (a) To be designed for Continuous duty as well for two shift or one shift operation.
- (b) To be designed for parallel operation of both streams.
- (c) Flexibility to operate electrolyser in part load.
- (d) Complete operation from microprocessor based proprietary control system.
- (e) To trip the plant in case of high hydrogen level inside the building suitable numbers of hydrogen gas detectors to be provided by the bidder for each of the room.
- (f) Set pressure to be maintained with help of back pressure regulation valve.
- (g) Automatic operation of standby compressor as and when required.
- (h) To provide alarm & tripping of compressor based on suction conditions.

36.5 DESIGN AND CONSTRUCTION

36.5.1 Electrolyser/ Generator (as applicable)

- (a.) Cells in electrolyser / generator shall be connected to each other. Further for Unipolar design, there shall be provision to isolate any one of the Cells in electrolyser. The Cells in electrolyser / generator shall be of corrosion resistant material.
- (b.) The electrolyser/ generator to be designed to operate at part load of normal capacity without any disconnection and operation interruption and shall produce the hydrogen gas of specified purity and dryness.
- (c.) All measuring instruments, controllers and control valves shall be provided.
- (d.) Safety devices are to be provided on each collecting pipe to release gas pressure in case it goes above the limits.
- (e.) To be designed so that it can be dismantled, cleaned, and reassembled easily.

- (f.) Proper sealing shall be provided by the Bidder while crossing the wall to avoid any gas leakage to Rectifier Room.
- (g.) Each electrolyser/ generator shall be fitted with the following instrumentation as minimum.
- (1.) In unipolar design one explosion proof temperature switch in each cell for electrolyser temperature high alarm on the control panel. In case of bipolar design one explosion proof temperature switch in each generator module for electrolyser temperature high alarm on the control panel.
 - (2.) A local pneumatic temperature controller, controlled through control system, to maintain the electrolyser temperature to a preset value by controlling cooling water flow to the electrolyser through the temperature control valve.
 - (3.) One temperature gauge for local indication for electrolyte temperature.
 - (4.) One off-line specific gravity measuring instrument.

36.5.2 Rectifier (if applicable)

Two nos. of rectifier (one for each electrolyser) to cater to the load of each of the electrolyser. The rectifier equipment shall be complete in all respects with air-cooled rectifier transformer, thyristor converter, electronic control and annunciation, fillers choke etc mounted in suitable panels.

36.5.3 Gas washing Tanks (if applicable)

One for each electrolyser with manometers at inlet and outlet, temperature gauge, level switches for controlling the level of DM water in the tank etc.

36.5.4 Demineralised water tank

- (a.) DM water storage tank for Hydrogen Generation Plant shall have a net storage capacity to meet five days normal requirement of Hydrogen gas generation.
- (b.) To be fitted with removable drain connections, level switches/ transmitter, level indicators etc.

36.5.5 Caustic solution mixing tank (if applicable)

- i) Capacity - Suitable to fill one electrolyser
- ii) Material - High Density PVC
- iii) Accessories - Removable cover, motor operated pump, instrument as required
- iv) Pump (if applicable) - Suitable to pump alkali upto the cells with discharge flexible hose, differential pressure gauge across suction filter, pressure gauge at pump discharge etc.

36.5.6 Hydrogen gas Holders (for unipolar design)

- i) Number: Two (2) numbers (one for filling, one for supply to compressor)
- ii) Capacity of each gas holder: Minimum of 10 M³ (Bidder to indicate data as suitable for the system)
- iii) Material: IS-2062/2002 or equivalent
- iv) To be designed for outdoor duty.
- v) To provided with two (2) Seal pots for each gas holder.
- vi) Accessories such as Wire rope, Counter weight, guide pulley required to suspend the gas holders, steel stairs four-way motorized valves, flame proof low & high level switches for interlock and control, float type level indicators, etc.
- vii) Venting of hydrogen shall be through flame arrestor.

36.5.7 De-oxy unit (if applicable)

- i) Numbers: 1 (To handle both the streams and capable to remove oxygen as impurity)
- ii) Accessories: Heater with temperature control device, gas cooler, filter, necessary instruments etc.

36.5.8 Hydrogen compressors and drives

- i) Number: 3x50% (two working & one standby)
- ii) Capacity of each compressor: 125% of each stream
- iii) Design delivery Pressure: 140 kg/cm² (g)
- iv) Type: Preferably Oil free, Piston or Diaphragm type
- v) Piston type: Of proven design
- vi) Diaphragm type: Triple diaphragm failure detection system. The side and oil side diaphragms shall be of stainless steel.
- viii) Activated carbon filters: 2x100% and required in case of oil lubricated compressor
- ix) All metal to metal joints shall be provided with "O" rings of suitable grade material.
- ix) To provide auxiliaries such as built in relief valves, Pressure and temperature gauges after every compression stages, mechanical lubricator, built in automatic unloader devices. Water cooled inter coolers after every compression stage, flow switches, pressure gauges

in coolant line, sight flow indicators in coolant line, V belt drive with pulleys, a transfer switch to allow operation of standby compressor automatically, suction filters, scrubber to remove any traces of entrapped electrolyte, separator and filters, suitable protection device to prevent suction of water from gas holders as a back-up to low level switch provided on the gas holders for compressor TRIP, Mist Eliminators One number on-line hydrogen purity analyzer at the suction etc.

- x) To make arrangement for continuously monitoring hydrogen purity before compressor and before filling of gas into cylinders and to provide suitable alarm and automatic tripping of plant in case, hydrogen purity falls below the preset level.

36.5.9 Drying system for Hydrogen gas (if applicable)

- (a.) To provide twin tower Moisture separating columns of Regenerative design along with instruments.
- (b.) To provide valves arrangement to suit operation of one Column & another under regeneration. The operation shall be automatic based on control system command.

36.5.10 Back Pressure regulating valve

- (a.) Spring loaded disc operated self actuating type back pressure regulating valve to maintain 140 kg/cm² (g) pressure on the compressor discharge.
- (b.) To be provided with accessories such as Pressure sensing element, controller etc.

36.5.11 Cylinder Manifold

- (a.) To provide one dual cylinder filling manifold, arranged for two banks of minimum four (4) nos. cylinders each.
- (b.) To provide accessories such as Isolating valves, safety valves, Pressure gauges, pressure switch (To shut-off compressors beyond set pressure) "ON-LINE" Hydrogen purity analyser, trace oxygen analyzer, moisture analyzer at cylinder manifold, records of hydrogen purity and moisture content, & one number PORTABLE hydrogen gas purity testing kit.

36.5.12 Flushing System

To be provided with necessary connection with proper isolation devices, nitrogen cylinders, valves, manifolds piping etc to enable purging the system with nitrogen commissioning and each maintenance work.

36.5.13 Hydrogen leak detection system:

Hydrogen leak detection and interlock system shall be provided in generator/compressor rooms and hydrogen filling area for alarm and trip of Hydrogen generation plant. This system shall have interface with Hydrogen Generation System PLC.

36.5.15 Piping

- (a.) All Pipe to conform to ASA pressure piping code, and seam less type.
- (b.) All high pressure joints shall of ferrule/ welded construction.

- (c.) All vents to be fitted with flame arrestor.
- (d.) All high pressure drains to be terminated through H₂ traps and all low pressure drains to be terminated through U-bends.
- (e.) Cooling water pipe be minimum 80 NB size.

36.6 HVAC SYSTEM

36.6.1 Air Conditioning System

- (a.) Air conditioning system shall be provided for the Control Room of the Hydrogen Generation Plant by installing non duct-able split air conditioners with 100% stand-by modules.

36.6.2 Ventilation System

- (a.) Axial flow fans for exhausting air/fumes shall be provided for hydrogen generation room & associated H₂ compressor room and H₂ cylinder area. Such fans shall be of flame proof construction with inlet and outlet dampers, motorized fire damper, protective wire netting inside the rooms, and rain protection cowl with bird screen. Drive motor shall also be of flame proof construction. Wall mounted air intake louver shall be provided for air entry. A negative pressure shall be maintained inside the said areas.

The air quantity of ventilation system shall be estimated based on a minimum number of air changes of 30 per hour. The exhaust air shall be discharged at a suitable height from the room.

- (b.) Both Supply and exhaust ventilation system shall be provided for the Feed water & Lye making room. Supply system shall consist of wall mounted axial flow fan with drive motor, rain protection cowl with bird screen and protective wire netting at the outlet inside the room.

Exhaust system shall consist of axial flow fan, drive motor, protective wire netting inside the room, rain protection cowl with bird screen etc

The air quantity of ventilation system shall be estimated based on a minimum number of air changes of 10 per hour. The exhaust air shall be discharged at a suitable height from the room.

- (c.) Pressurized ventilation system shall be provided for the Electrical room housing MCCs, rectifiers UPS etc. This system shall consist of wall mounted Fan-filter units for filtered and fresh air supply to the room. Hot air shall be exhausted through the wall mounted back draft dampers maintaining a little overpressure inside the room.

Each supply Fan-filter unit comprises air inlet louver, dry panel type HDPE filters, axial flow fan with drive motor, GI casing, supply cowl with bird screen, supports, supporting bracket, vibration isolators etc. The air quantity of ventilation system for electrical room shall be estimated based on a minimum number of air changes of 15 per hour or actual heat load basis (considering a maximum temperature rise of 3°C above ambient), whichever is higher.

36.7 CONTROL AND INSTRUMENTATION

Instrumentation requirements indicated in this specification are based on typical configuration of the plant for the purpose of bidding only. Bidder shall offer all necessary instruments such as transmitters / temperature elements / sensors / switches / gauges etc. to meet the actual functional requirement of the specification and for safe, efficient & reliable operation and maintenance of the

H₂ generation plant. Control & operation of Hydrogen Generation Plant shall be envisaged through a microprocessor based proprietary control system with PC based workstation. Hot redundant PLC shall be provided. For further details VOLUME V of this specification shall be referred.

36.8 ELECTRICAL

- 36.8.1 All electrical equipment and accessories as required for the system shall be supplied. UPS system with PLANTE battery shall be provided. These equipment and accessories shall be designed, constructed and installed in accordance with the relevant electrical specifications (refer Volume IV of this EPC specification) and relevant Indian Standards/IEC Standards.
- 36.8.2 The electrical work shall be carried out in compliance with Indian Electricity rules, acts and CEA recommendation.
- 36.8.3 All electrical equipment and installation work located in Hydrogen Gas Plant area or coming in contact with Hydrogen atmosphere except in the following areas shall be explosion proof conforming to group IIC of IS-2148 and other relevant IS and shall be got approved by the Contractor from Explosive Authorities.
- a) Electrical Control room.
 - b) Laboratory and Office.
 - c) General Store.
 - d) Toilet.

36.9 SAFETY REQUIREMENT

The equipment should be built according to the international standards and should fulfill the necessary CCE approval requirements towards pressure vessel directives and explosion hazardous area.

The H₂ Plant shall meet the requirements of department of Explosives, Nagpur, Indian explosive rules and Indian factories act along with other safety requirements.

The complete process, together with all relevant parameters, should be constantly monitored and controlled by a microprocessor. Each action that might cause a dangerous situation should be by passed by a Hard Wired Safety System. In case small malfunction of the microprocessor or in an emergency situation, the unit should shut down immediately.

Hydrogen in the atmosphere should be constantly checked and if hydrogen in the atmosphere is detected at a level of 20% of Lower Explosion Level (LEL) for hydrogen (4%), the unit should immediately stop production and put itself in standby.

Pressure transmitter should constantly monitor and controls the system pressure. If the system pressure increases out of range, the production will be stopped and will put in standby. A temperature transmitter should constantly monitor and control the electrolyte temperature. The electrolyte levels should be measured by a level transmitter and should be controlled by a level controller.

Safety devices to protect microprocessor against power line disturbance will be provided. The system should be capable of taking electrical surges.

36.10 INSPECTION AND TESTING

The equipment to be supplied under this specification shall have assured quality and workmanship. The Bidder in his proposal shall submit his Quality Assurance Plan containing quality assurance programme and quality assurance documents for Purchaser's approval. The Contractor shall be bound to conduct all stage inspections on various equipment/ materials during manufacturing process in accordance with the approved copy of this document. Purchaser shall have the right to carry out Quality Audit and Quality Surveillance by witnessing any or all such tests to be carried out at Contractor's/ Sub-contractor's works as and when desired. The procedure applicable to Contractor's works will also apply to the works of his sub-contractors. For items coming under the purview of any Indian Statutory Regulation during the course of manufacture, all stage inspections and tests shall be witnessed by an inspecting authority recognized under the statutory regulation.

These audit/surveillance/approvals shall not, however, relieve the manufacturer/sub-vendors of their responsibility of the Quality Assurance of their product, and the overall guarantee and responsibility shall wholly be binding on the Bidder.

Tests/inspections for all the equipment shall be carried out at Manufacturer's/Sub-Vendor's works during and after the completion of manufacture of different components and assembly as applicable in accordance with the relevant codes and standards and as indicated in Sub-Sections attached with this specification. The test Certificates for all such tests/ inspections and their procedure shall be submitted to the Purchaser for approval.

Purchaser or his authorized representative shall have full access to witness any or all tests/ inspections to be carried out at manufacturer's shop. In case, the job is sub-contracted, it will be Contractor's responsibility to make all arrangements so that Purchaser or his authorized representative can attend such tests at Sub-Contractor's premises.

Test results shall also be submitted after conducting the tests, for Purchaser's approval.

Where stage inspection is to be carried out for witnessing the tests as mentioned, the successful Bidder shall submit to the Purchaser at the initiation of the contract, the detailed PERT chart showing the manufacturing programme and indicating the period where Purchaser's inspection agency are required at the shop for witnessing the tests. At least two weeks' advance notice shall also be given before the inspection date to enable the Purchaser or his authorized representative to be present during the tests.

36.11 PAINTING

All the Piping, Valves and Equipments of this system shall be protected against external corrosion by providing suitable painting as applicable for the seawater environment in coastal area.

EMPTY HYDROGEN / NITROGEN CYLINDER (46.7 liters water capacity)

1.0 SCOPE

This specification covers the design, manufacture, testing and supply of empty seamless hydrogen cylinders as per the requirements specified herein.

2.0 STANDARD APPLICABLE

Latest edition of IS:3224 and IS:7285

3.0 DIMENSIONS

a.	Outside diameter	-	232 mm
b.	Cylinder wall thickness	-	5.4 mm (min)
c.	Overall length	-	1445 mm

4.0 DESIGN

The top end should be necked down to 2" dia and screw internally to dia 1" standard taper 1 in 8, 14 TPI to IS :3224. The bottom of cylinder shall be concave.

5.0 FITTINGS

The gas cylinders should be complete with the following fittings/ accessories.

- Neck collar
- Protection cap
- Outlet valve to IS:3224
- Safety valve/Bursting disc.

6.0 CAPACITY

a.	Water capacity	-	46.7 liters
b.	Volume gas	-	7m ³ (app.)

7.0 WORKING PRESSURE

- 150kg/cm²

8.0 MATERIAL

The cylinders shall conform to IS:7285 and shall be made of seam less solid drawn high carbon manganese steel. The valve body shall be made of brass and internals of stainless steel.

9.0 REQUIREMENT OF CYLINDERS

As per IS:7285

10.0 PAINTING & MARKING ON CYLINDERS

To be as per IS : 7285

11.0 INFORMATION REQUIRED WITH THE OFFER

Cylinder drawing indicating the following details:

- The standard to which cylinders and fittings conform.
- Capacity, size and wall thickness of cylinder.
- Details and arrangement of fittings.
- Minimum wall thickness of cylinder.

- e) Working pressure, pneumatic test pressure, hydraulic test pressure and hydraulic stretch test pressure.

12.0

TEST CERTIFICATES

- a) Test certificates for all the tests indicated in clause 9.0 of this specification.
- b) Manufacturer shall furnish inspection certificate from BIS and approval certificate from deptt. of explosive Nagpur.

13.0

GENERAL

- a) The offer submitted shall be strictly in line with the requirements specified in this specification.
- b) All the documents as required in clause 12 and 13 shall be submitted in 5 copies.

CHAPTER 5 : GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

This part covers technical requirements, which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.

2.0 BRAND NAME

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Owner to determine that the products proposed are equivalent or superior to those named.

3.0 BASE OFFER & ALTERNATE PROPOSALS

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Owner. Sufficient amount of information for justifying such proposals shall be furnished to Owner along with the bid to enable the Owner to determine the acceptability of these proposals.

4.0 COMPLETENESS OF FACILITIES

- 4.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.
- 4.2 All equipments furnished by the Bidder shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.
- 4.3 All similar standard components/ parts of similar standard equipment provided shall be interchangeable with one another.

5.0 Codes & Standards

- 5.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

- (a.) Bureau of Indian Standards (BIS)
- (b.) Indian Electricity Act (2003)
- (c.) Indian Electricity Rules
- (d.) Indian Explosives Act
- (e.) Indian Factories Act and State Factories Act
- (f.) Indian Boiler Regulations (IBR)
- (g.) Regulation of Central Electricity Authority
- (h.) Regulations of the Central Pollution Control Board, India
- (i.) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- (j.) Pollution Control Regulations by Department of Environment, Government of India
- (k.) State Pollution Control Board.
- (l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
- (m.) Explosive Rules, 1983
- (n.) Petroleum Rules, 1976,
- (o.) Gas Cylinder Rules, 1981
- (p.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
- (q.) Workmen's Compensation Rules, 1924
- (r.) Rules for Electrical installation by Tariff Advisory Committee (TAC) and appropriate Electrical Inspectorate.
- (s.) Owner's Safety Policy
- (t.) Any other statutory codes / standards / regulations, as may be applicable.

5.2 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

- (a.) British Standards (BS)
- (b.) Japanese Industrial Standards (JIS)
- (c.) American National Standards Institute (ANSI)
- (d.) American Society of Testing and Materials (ASTM)
- (e.) American Society of Mechanical Engineers (ASME)
- (f.) American Petroleum Institute (API)
- (g.) Standards of the Hydraulic Institute, U.S.A.
- (h.) International Organisation for Standardization (ISO)
- (i.) Tubular Exchanger Manufacturer's Association (TEMA)
- (j.) American Welding Society (AWS)
- (k.) Cooling Tower Institute (CTI)
- (l.) National Electrical Manufacturers Association (NEMA)
- (m.) National Fire Protection Association (NFPA)
- (n.) International Electro-Technical Commission (IEC)
- (o.) Expansion Joint Manufacturers Association (EJMA)
- (p.) Heat Exchange Institute (HEI)
- (q.) IEEE standard
- (r.) JEC standard

5.3 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish

specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

- 5.4 As regards highly standardized equipments such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.
- 5.5 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
- 5.6 Two (2) English language copies of all-national and international codes and/or standards used in the design of the plant, equipment, civil and structural works shall be provided by the Bidder to the Owner within two calendar months from the date of the Notification of Award.
- 5.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

6.0 EQUIPMENT FUNCTIONAL GUARANTEE

- 6.1 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.
- 6.2 The functional guarantees of the equipment under the scope of the Contract shall be as per "Chapter 8 - Functional Guarantee & LD", Volume-II. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.
- 6.3 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.

7.0 DESIGN OF FACILITIES / MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.1 Design of Facilities

- 7.1.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.
- 7.1.2 The Bidder shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the

rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.2 Maintenance and Availability Considerations

- 7.2.1 Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.
- 7.2.2 Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.
- 7.2.3 Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.
- 7.2.4 Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

8.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

- 8.1 Plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

The Contractor shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

- 8.2 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I attached with Chapter 5, Volume-II.
- 8.3 The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

8.3.1 Basic Engineering Documentation

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Plant Definition Manual within 4-6 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:-

- 1) System description of all the mechanical, electrical, control & instrumentation & civil systems.

- 2) Technology scans for each system / sub-system & equipment.
- 3) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
- 4) Optimization studies including thermal cycle optimization.
- 5) Sizing criteria of all the systems, sub-systems including various piping systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- 6) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- 7) Operation Philosophy and the control philosophy of the Main Plant and other plants.
- 8) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in native (Word, Excell, ACAD etc) in the form of CD discs to the Owner for engineering of areas not included in Bidder's scope.
- 9) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.
- 10) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.

After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

8.3.2 Detailed Engineering Documentation

- 1) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
- 2) Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.
- 3) Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start-up.
- 4) Piping isometric, composite layout and fabrication drawings.
- 5) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.
- 6) Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.

- 7) Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.
- 8) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
- 9) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.
- 10) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- 11) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- 12) Model Studies/ CFD analysis for ESP, CW sump etc and furnishing report with recommendations.
- 13) Characteristic Curves/ Performance Correction Curves and thermal design calculations for Cooling Tower.
- 14) Composite Water Balance for total Plant.
- 15) Hydraulic calculation/profile for Water Treatment Plant.
- 16) Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.
- 17) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- 18) Protection systems diagrams and relay settings. Load Flow study.
- 19) Interconnection diagrams.
- 20) Cable routing plan.
- 21) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
- 22) Alarm and annunciation list and alarms & trip set points.
- 23) Sequence and protection interlock schemes.
- 24) Type test reports and power system stability study report.
- 25) Control system configuration diagrams and card circuit diagrams and maintenance details.

- 26) Detailed software manuals & source software listing.
- 27) Detailed flow chart for digital control system.
- 28) Mimic diagram layout.
- 29) Civil Task drawings (for the Engineering by Owner), Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- 30) Model study reports wherever applicable.
- 31) Functional & guarantee test procedures and test reports.
- 32) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- 33) Documentation in respect of commissioning as listed out elsewhere in this specification.

The Bidder while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.3.2 Instruction Manuals

The Bidder shall submit to the Owner, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Owner the Instruction Manuals shall be submitted as indicated in Annexure-IV. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Owner. The Instruction Manuals shall comprise of the following.

A) Erection Manuals

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

- 1) Erection strategy.
- 2) Sequence of erection.
- 3) Erection instructions.
- 4) Critical checks and permissible deviation/tolerances.
- 5) List of tool, tackles, heavy equipments like cranes, dozers, etc.
- 6) Bill of Materials
- 7) Procedure for erection.

- 8) General safety procedures to follow during erection/installation.
- 9) Procedure for initial checking after erection.
- 10) Procedure for testing and acceptance norms.
- 11) Procedure / Check list for pre-commissioning activities.
- 12) Procedure / Check list for commissioning of the system.
- 13) Safety precautions to be followed in electrical supply distribution during erection

B) Operation & Maintenance Manuals

- a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

- b) The arrangement and contents of O&M manuals shall be as follows :

1) Chapter 1 - Plant Description :

To contain the following sections specific to the equipment/system supplied

- i.) Description of operating principle of equipment / system with schematic drawing / layouts.
- ii.) Functional description of associated accessories / controls. Control interlock protection writes up.
- iii.) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).
- iv.) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.
- v.) Design data against which the plant performance will be compared.
- vi.) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.
- vii.) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

- viii.) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation:

To contain the following sections specific to the equipment supplied

- i.) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.
- ii.) Limiting values of all protection settings.
- iii.) Various settings of annunciation/interlocks provided.
- iv.) Start-up and shut down procedure for equipment alongwith the associated systems in step mode.
- v.) Do's and Don'ts related to operation of the equipment
- vi.) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.
- vii.) Parameters to be monitored with normal value and limiting values.
- viii.) Equipment isolating procedures.
- ix.) Trouble shooting with causes and remedial measures.
- x.) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.
- xi.) Routine Operational Checks, Recommended Logs and Records
- xii.) Change over schedule if more than one auxiliary for the same purpose is given.
- xiii.) System/plant commissioning procedure.
- xiv.) Preservation procedure on long shut down.

3) Chapter 3.0 - Plant Maintenance

To contain the following sections specific to the equipment supplied

- i.) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.
- ii.) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment
- iii.) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc

- iv.) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.
- v.) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out
- vi.) Overhauling schedules linked with running hours/calendar period alongwith checks to be done
- vii.) Long term maintenance schedules
- viii.) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling
- ix.) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement
- x.) Tolerance for fitment of various components
- xi.) Details of sub vendors with their part no. in case of bought out items
- xii.) List of spare parts with their Part No, total population, life expediency & their interchange ability with already supplied spares to OWNER.
- xiii.) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.
- xiv.) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares
- xv.) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

8.3.2.2 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

8.3.2.3 If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O&M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

8.3.3 Plant Handbook and Project Completion Report

8.3.3.1 Plant Handbook

The Bidder shall submit to the Owner a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

- 1) Design and performance data.
- 2) Process & Instrumentation diagrams.
- 3) Single line diagrams.
- 4) Sequence & Protection Interlock Schemes.
- 5) Alarm and trip values.
- 6) Performance Curves.
- 7) General layout plan and layout of main plant building and auxiliary buildings.
- 8) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.3.3.2 Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.3.4 Drawings

- a)
 - i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.
 - ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-VI (GTR)-Vol-II.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.
 - iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per Annexure-VI (GTR), Vol-II.
 - iv) The completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to Employer,

along with the design review software (network ready) which shall include interference check, walk-through animation, simulation, visual effect, photo realism etc. loaded on a server with four (4) work stations (latest configuration for server & workstation) with one A4 size colored laser printer and one A0 size colored plotter. The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer.

The requisite hardware and software shall be supplied and commissioned by the Contractor at Employer's Head Office at Lucknow & Site Office at Panki as per mutually agreed schedule.

All softwares provided shall necessarily include the cost for perpetual license(s) for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three (3) years after warranty/guarantee period.

- b) All documents/text information shall be in latest version of MS Office or MS Excel as applicable.
- c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.
- d) Each drawing submitted by the Contractor (including those of sub vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- e) The drawings submitted by the Contractor (or their subvendor) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.
- f) The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- g) Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature

- h) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.
- i) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.
- j) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer.
- k) However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.
- l) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
- m) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
- n) As Built Drawings**
After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to "as built" conditions in requisite number.
- o) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall

not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/documents for the same.

- p) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.
- q) All engineering data submitted by the Bidder after final process including review and approval by the Project Manager/Owner shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

8.4 Engineering Information Submission Schedule

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Owner. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.

- a) Information that shall be submitted for the approval of the Owner before proceeding further, and
- b) Information that would be submitted for Owner's information only.

The Master Drawing List (MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.5 Engineering Progress and Exception Report

8.5.1 Report giving the status of each engineering information including

- a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

- b) Drawings which were not submitted as per agreed schedule including those for revision after commenting last revision .
- 8.5.2 The draft format for this report shall be furnished to the Owner within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the Owner.

8.6 Engineering Co-ordination Procedure

- 8.6.1 The following principal coordinators will be identified by respective organizations at time of award of contract:

Project Manager (UPRVUNL EC):

Name :
Designation :
Address
a) Postal :
b) Telegraphic /e-Mail :
c) FAX : TELEPHONE (Land & Mobile):

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :
Designation :
Address :
a) Postal :
b) Telegraphic /e-Mail :
c) FAX : TELEPHONE(Land & Mobile) :

- 8.6.2 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

- 8.6.3 Contractor's/Vendor's Drawing Submission and Approval Procedure:

- a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for OWNER'S information/ interface and or review and approval are referred by the general term "drawings".
- b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Owner before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.
- c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.
- d) Owner shall intimate the contractor, OWNER drawing number procedure. Vendor, thereafter, shall indicate OWNER drawing number in MDL and in subsequent Submission of drawing, in the space provided for this purpose in

title plate, in addition to his own drawing number, if any.

- e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/ documents for the same.
- f) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.
- g) The Contractor shall submit adequate prints of drawing / data / document for Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNER and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories/action:

CATEGORY/Action - 1	: Distributed
CATEGORY/Action - 2	: Approved

CATEGORY/Action - 3	: Approved, subject to incorporation of comments/ modification as noted. Forward final drawing Resubmit revised drawing incorporating the comments

CATEGORY/Action - 4	Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments

CATEGORY/Action - 5:	Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted in accompanying memo.

CATEGORY/Action - 6	: For information and records.

- h) Contractor shall resubmit the drawings marked/stamped under Category/Action 3,4 & 5 within two(2) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall

bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (e.g. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Owner's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Owner shall review only such revised portion of documents.**

- i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to OWNER for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- j) It shall be the responsibility of the Contractor/ Vendor to get all the drawings approved as the case may be and complete the engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.
- l) These comments will be taken care by the contractor while submitting the revised drawing.
- m) The contractor shall use a single transmittal for drawings Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

9.0 Technical Co-Ordination Meetings

- 9.1 The Bidder shall be called upon to organize and attend monthly Design/ Technical Co-ordination Meetings with the Owner / Owner's representatives / OWNER Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.
- 9.2 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owner as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the Owner shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.

- 9.2.1 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
- 9.2.2 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
- 9.3 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.

10.0 Design Improvements

The Owner or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.0 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

12.0 Protective Guards

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

13.0 Lubricants, Servo Fluids and Chemicals

- 13.1 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.
- 13.2 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.

14.0 Lubrication & Chemicals

Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

14.1 Chemicals for Water System

Bidder's scope include Chemical required for complete water system up to final handing over EPC package and further two (2) months plant operational requirement.

15.0 Material of Construction

All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.

16.0 Rating Plates, Name Plates & Labels

- 16.1 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.
- 16.2 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.
- 16.3 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.
- 16.4 Items of plant such as valves, which are subject to handling, shall be provided with engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.
- 16.5 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

- 16.6 Valves, steam traps and strainers shall be identified by Owner's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.
- 16.7 Safety and relief valves shall be provided with the following:
- a) Manufacturer's identification.
 - b) Nominal inlet and outlet sizes in mm.
 - c) Set pressure in Kg/cm² (abs).
 - d) Blowdown and accumulation as percentage of set pressure.
 - e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.
- 16.8 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
- 16.9 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system

17.0 Tools and Tackles

The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Owner.

18.0 Welding

- 18.1 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed by others the requirements shall be submitted to the Owner in advance of commencement of erection work.

19.0 Colour Code for all Equipments/ Pipings/ Pipe Services

- 19.1 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

20.0 Protection and Preservative Shop Coating

20.1 Protection

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a non-metallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Chapter 9, Volume II.

20.2 Preservative Shop Coating

- 20.2.1 All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.
- 20.2.2 Transformers and other electrical equipments if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.
- 20.3 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.
- 20.4 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.
- 20.5 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.
- 20.6 Painting for Civil structures shall be done as per relevant part of technical specification.

21.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points, as necessary. Such programs shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA program shall be generally in line

with ISO-9001/IS-14001. A quality assurance program of the contractor shall generally cover the following:

- a) His organization structure for the management and implementation of the proposed quality assurance program
- b) Quality System Manual
- c) Design Control System
- d) Documentation and Data Control System
- e) Qualification data for bidder's key personnel.
- f) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- g) System for shop manufacturing and site erection controls including process, fabrication and assembly.
- h) Control of non-conforming items and system for corrective actions and resolution of deviations.
- i) Inspection and test procedure both for manufacture and field activities.
- j) Control of calibration and testing of measuring testing equipment.
- k) System for Quality Audits.
- l) System for identification and appraisal of inspection status.
- m) System for authorising release of manufactured product to the Owner.
- n) System for handling, storage and delivery.
- o) System for maintenance of records, and
- p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as Annexure-I and Annexure-II respectively.

22.0 General Requirements - Quality Assurance

- 22.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule

of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

- 22.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. CD or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.
- 22.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 22.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.
- 22.5 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 22.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 22.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the format enclosed at Annexure-V. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
- 22.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.

- 22.9 All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.
- 22.10 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.
- 22.11 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 22.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 22.13 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 22.14 No welding shall be carried out on cast iron components for repair.
- 22.15 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 22.16 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.
- 22.17 All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.
- 22.18 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.
- 22.19 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's

purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.

22.20 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

22.21 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

22.22 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.23 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.24 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.

22.25 Environmental Stress Screening

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following

- 1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

OR

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two number or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

2) Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

- 22.26 The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

23.0 QA Documentation Package

- 23.1 The Bidder shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (✓) mark.

- 23.1.1 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

- 23.2 Typical contents of QA Documentation are as below:-

- a) Quality Plan
- b) Material mill test reports on components as specified by the specification and approved Quality Plans.
- c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- e) Heat Treatment Certificate/Record (Time- temperature Chart)
- f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- g) CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
- h) Certificate of Conformance (COC) wherever applicable.
- i) MDCC

- 23.3 Similarly, the Bidder shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

- 23.4 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
- b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality

document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

- c) If a decision is made despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

23.5 Transmission of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Quality Assurance Department (@ Head Office) and other set to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.0 Project Manager's Supervision

24.1 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

24.2 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

- a) Interpretation of all the terms and conditions of these documents and specifications:
- b) Review and interpretation of all the Bidder's drawing, engineering data, etc:
- c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :
- d) Inspect, accept or reject any equipment, material and work under the contract.
- e) Issue certificate of acceptance and/or progressive payment and final payment certificates
- f) Review and suggest modifications and improvement in completion schedules from time to time, and

- g) Supervise Quality Assurance Programme implementation at all stages of the works.

25.0 Inspection, Testing and Inspection Certificates

- 25.1 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.
- 25.2 The Project Manager or his duly authorized representative and/or an outside inspection agency acting on behalf of the Owner shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.
- 25.3 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
- 25.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
- 25.5 When the factory tests have been completed at the Bidder's or sub-Bidder's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 25.6 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorized representatives to carry out effectively such tests on the equipment in accordance with the

Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.

- 25.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.
- 25.8 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03 of this chapter, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 25.9 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.

25.10 Associated document for quality assurance programme:

- 25.10.1 List of items requiring quality plan and sub supplier approval. (Annexure-III).
- 25.10.2 Status of items requiring Quality Plan and sub supplier approval (Annexure-IV)
- 25.10.3 Field Welding Schedule (Annexure-V).
- 25.10.4 Manufacturing Quality Plan (Annexure-I).
- 25.10.5 Field Quality Plan (Annexure-II).

25.11 TESTING OF MAJOR DESIGN FEATURES OF I&C SYSTEM:

The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within four months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design & finalization of important engineering documents like configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfil the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following

- A) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.
- B) Loop reaction time for sample loops/ logics
- C) SOE functionality tests
- D) Server changeover
- E) Various response times, having serious implication on operation & maintenance philosophy

- F) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.
- G) Unified HMI for DDCMIS

The results of the above tests, after its acceptance by the Owner, shall be properly documented and submitted to Owner.

25.12 DEMONSTRATION OF APPLICATION ENGINEERING

2.12.1 Based on UPRVUNL inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following

i) Logics/Loops:

- a) Drive logics implementation for each type of binary drive along with its display in HMI.
- b) Sequence implementation along with its display in HMI.
- c) Single non-cascade controller implementation.
- d) Cascade loop implementation.
- e) Master slave implementation with different slave combination.
- f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable

ii) HMI Functions:

- a) LVS Annunciation.
- b) Graphics.
- c) HSR
- d) Logs/Reports.
- e) Calculations (Basic & Performance Calculations).

25.12.2 The above typical cases shall be finalized with the Owner through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on UPRVUNL inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by the Owner and demonstrate to Owner at Owner premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Owner premises & the results shall be documented as part of test report.

25.12.3 During the integrated testing at the Contractor's works, only sample checks shall be done by the Owner for the items covered in above application engineering demonstration.

**26.0 PRE-COMMISSIONING, COMMISSIONING, TRIAL OPERATION,
 PERFORMANCE TEST**

- 26.1 a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Owner and the Bidder for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- b) The Bidder's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.
- c) It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spars required for successful commissioning of all the equipment covered under the contract. Such a list shall be furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.
- d) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Owner six months prior to the respective implementations. The Owner will approve final verification of cleanliness.
- e) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.
- f) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.
- g) The Bidder during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at

the base load, peak load as well as lowest sustained operating condition as far as practicable.

26.1.1 Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain:

- a) Biodata including experience of the Commissioning Engineers.
- b) Role and responsibilities of the Commissioning Organisation members.
- c) Expected duration of posting of the above Commissioning Engineers at site.

26.2 Initial Operation / Trail Operation Test

- a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.
- b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

The Initial Operation Test shall be considered successful, if during the above period of initial operation, the 660MW unit shall generates a minimum of 451 million kWhrs*, as measured at generator terminals.

- c) The Initial Operation shall be considered successful, provided that each item/ part of the facility has operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.
- d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.
- e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.
- f) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications / repairs to the plant shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe

operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

(* - shall be appropriately adjusted for any generation loss attributable to Employer.)

26.3 Guarantee Tests

- a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test. Such test will be commenced, within a period of **three (3) months** after the successful completion of Initial Operations. Any extension of time beyond the above **three (3) months** shall be mutually agreed upon.
- b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.
- c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
- d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
- e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specification.

27.0 TAKING OVER

Upon successful completion of Initial Operations and all the tests (including all PG test) conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

28.0 TRAINING OF OWNER'S PERSONNEL

28.1 The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:

- a) Training for Steam Generator & ESP Equipment, TG & Auxiliaries and related equipments.
- b) Training for Electric Systems including VFD and Electric power supply system.
- c) Training for other SG/TG related C&I systems/equipments including training on Flame Monitoring System, Furnace and Flame Viewing System, Turbine Supervisory System (TSS) including vibration analyzer, vibration monitoring system axial shift, eccentricity measurements etc. for Main Turbine, BFP Turbine etc. Burner management study, control loop study, misc system for SG C&I, EHTC, Turbine stress control system, Turbine protection system, ATRS, instrumentation etc.
- d) Training for special packages for various PC based systems.
- e) Training for various C&I systems/equipment supplied includes the following:
 - i. DDCMIS - Human Machine Interface – Hardware & Operating System
 - ii. DDCMIS-Human Machine Interface System Engineering & Application Software.
 - iii. DDCMIS – Control System Hardware and Control system Application Software.
 - iv. DDCMIS – Operator Training: Use of the system at Works + at site.
 - v. DDCMIS – Specialized Network security.
- f) Training for power cycle piping/critical piping.
- g) Training for UPS systems Annunciation system, SWAS, PA system, flue gas analysers, CCTV and 24 VDC systems.
- h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.
- i) Details of training modules for Mechanical, Electrical and C&I systems are given at Annexure – VII,

The exact details, extent and schedule for training shall be as finalised during detailed engineering and shall be subject to Owner's approval.

- 28.2 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module as indicated in Annexure – VII. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc.
- 28.3 Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.

- 28.4 Four (4) man month and two (2) man month training for OWNER Engineering Personnel on the offered CFD modelling code for SG & ESP including alternative geometry modeling technique shall be provided.
- 28.5 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (Annexure – VII for O&M and Engineering) is indicative only. Owner reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.
- 28.6 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.
- 28.7 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's (within Employer's Country) it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 28.8 In case the training of Owner's personnel is arranged at the works of the manufacturer's (outside Employer's Country) it shall be noted that the all the expenses including travel, air fare, application processing fees, lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 28.9 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award.
- 28.10** In addition to above, the contractor shall also arrange for training of 30 Owner's Personnel at a running 660 MW unit on operation of power station, for a period of six (6) months. The training shall be conducted before commissioning of the unit. The lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

29.0 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

- a) Working platforms should be fenced and shall have means of access.
- b) Ladders in accordance with Owner's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

30.0 Noise level

The equivalent 'A' weighted sound pressure level measured at a height of 1.0 m above floor level in elevation and at a distance of one (1) meter horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

- a) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.
- b) Regulating drain valves in which case it shall be limited to 90 dBA.
- c) TG unit in which case it shall not exceed 90 dBA.
- d) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 85 dBA.
- e) Mill noise which will be limited to 85-90 dBA.

31.0 PACKAGING AND TRANSPORTATION

All the equipments & spares shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

32.0 ELECTRICAL EQUIPMENTS/ENCLOSURES

All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.

33.0 Instrumentation and Control

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

- 33.1 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm ²). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
c)	Draught	-	Millimeters of water column (mm wc).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (mmWcl).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15 deg.C
i)	Density		Grams per cubic centimeter.

- 33.2 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

- 33.3 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

34.0 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

35.0 SURGE PROTECTIONS FOR SOLID STATE EQUIPMENT

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates etc. shall be submitted by the Bidder.

36.0 Instrument Air System

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power

cylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

37.0 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

- a) Temperature test pockets with stub and thermowell.
- b) Pressure test pockets

38.0 SYSTEM DOCUMENTATION (DDCIMS)

The Bidder shall provide drawings, system overview & description, hardware/software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C&I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Owner during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I "Technical Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

- 38.1 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Owner.

39.0 MAINTENANCE MANUALS OF ELECTRONIC MODULES

The Contractor shall have to furnish two(2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further, the contractor shall furnish a set of operating manuals which should include block diagrams, make,

model/type, details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

40.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

- 40.1 The Power Plant will be developed based on the guidelines of the State Environmental Authorities and that of MoEF. Suitable provisions will be incorporated in the design of buildings, structures, and selection of equipment, so that there are no adverse effects due to emissions, noise, and contamination of soil, water and air.
- 40.2 One single flue stack of 275 meter will be provided for 660 MW unit for wider dispersion of pollutant as per environmental guidelines.

41.0 LIST OF CODES AND STANDARDS

←---	Indian Standards Title	-->	← International and international recognized Standards →
IS: 277	Galvanised steel sheets (plain or corrugated)		
IS: 655	Specification for metal air duct		
IS: 800	Code of practice for use of structural steel in general building construction 1-1952		BS 449:1969 BS 5950 ASA A57,
IS: 807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Association of Australia) DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960BS 1757:1951 BS 2573:part-I:1960		Draft Revision, A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev
IS:875	Code of practice for design loads (other than Canadaearthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)		National Building code of (1953)-Part-IV Design section 4.1

Chapter 27: LP PIPING, VALVES & SPECIALITIES**27.0 LP PIPING, VALVES & SPECIALITIES****27.1 Equipment sizing Criteria**

- 27.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.
- 27.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.
- 27.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application**Water Velocity in m/sec**

	Pipe Size	Below 50 mm	50-150 mm	200 mm & above
a)	Pump suction	-----	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	----	1.5 - 2.4	2.1 - 2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 m/s inside the pipelines at pump discharge.

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air – 15.0 m/sec. (under Average Pressure & Temp. conditions)

- 27.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
- 27.1.5 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
- 27.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
- 27.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
- 27.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
- 27.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.
- 27.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
- 27.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
- 27.1.12 Threaded joints shall be provided with Teflon sealant tapes.
- 27.1.13 Following types of valves shall be used for the system/service indicated.

System	Type of Valves					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	X	X	X	X	X	
Air		X	X	X	X	
Drains & Vents			X	X	X	
Fuel oil		X	X	X	X	X

In water service, valves above 200 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30% design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

27.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

27.2.00 TECHNICAL SPECIFICATION

27.1.00 GENERAL

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/supports, tanks etc.

27.2.00 Pipes and fittings

27.2.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness shall be adhered to. The bidder shall furnish the pipe sizing / thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

27.2.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.2.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

27.2.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

27.2.5 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

- 27.2.6 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
- 27.2.7 For rubber lined ERW pipes, beads shall be removed.
- 27.2.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.
- 27.2.9 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
- 27.2.10 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valve on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

27.3.00 Material

- 27.3.1 Alternate materials offered by Bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
- 27.3.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
- 27.3.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.
- 27.3.4 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.
- 27.3.5 Material of construction for pipes carrying various fluids shall be as follows:

1	Intake Water, Raw water, Ash water, Circulating Water (CW), Aux. Cooling water (ACW), clarified Water, CW blow down, *Effluent disposal, service water, AHP Seal Water, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. Buried CW pipes shall be encased in 500 mm thk RCC. At road crossings live loads should be considered and this encasing thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.

2	Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
3.	*Drinking (potable) water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
4.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system for colony (* marked) Ductile Iron (DI) pipes conforming to IS 8329 and for fittings IS 9523 can be offered as an alternate to the mild steel/ galvanized mild steel pipes as specified above for standalone or outside plant boundary stretches. Various design aspects of DI piping has been discussed later in Annexure-I.

- 27.3.6 In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS: 1239 Grade heavy except for demineralised water, drinking water and condensate spill lines.
- 27.3.7 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
- 27.3.8 In demineralised water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.
- Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
- 27.3.9 Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent

internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).

- 27.3.10 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
- 27.3.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
- 27.3.12 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.
- 27.3.13 Buried CW Pipes/ headers shall be minimum 12 mm thick, encased in 500 mm thk RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and increased adequately, if required.

27.4.0 Piping Wall Thickness

- 27.4.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.6 mm shall be considered while selecting the thickness.
- 27.4.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	30 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

- > NB 600 mm to NB 900 mm - 8.0 mm
- > NB 900 mm to NB 1200 mm - 10.0 mm
- > NB 1200 mm to 1400 mm - 12.0 mm
- > NB 1400 mm to 1600 mm - 14.0 mm
- > NB 1600 mm to NB 2200 mm - 16.0 mm
- > NB 2200 mm - 18.0 mm

NOTE: For buried CW pipe with 500 mm thick RCC encasing (as detailed in cl. no. 27.3.5), the minimum acceptable thickness shall be as indicated below.

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm	-	12.0 mm

27.5.00 Piping Layout

- 27.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.
- 27.5.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
- 27.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
- 27.5.4 Pipelines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.
- 27.5.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.
- 27.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
- 27.5.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.
- 27.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.
- 27.5.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.
- 27.5.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

27.6.00 Slope/Drains and Vents

- 27.6.1 Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent shall not be less than 15 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.
- 27.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.7.0 Pipe Joints

In general all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

27.7.1 Screwed Joints

- (a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS:554 unless specified otherwise.
- (b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

- (c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.
- (d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate pastes. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.
- (e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

27.7.2 Welded Joints

- (a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

27.7.3 Flanged Joints

- (a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.
- (b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.
- (c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

27.8.00 Bends/elbows/mitre bends/Tees/Reducers & other fittings

- 27.8.1 Unless otherwise specified elbows shall be of long radius type.

- 27.8.2 For pipe sizes up to 65 Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.
- 27.8.3 For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 250 Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be $1\frac{1}{2}$ times the nominal pipe diameter. 90 deg. Bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces $22\frac{1}{2}$ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.
- 27.8.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.
- 27.8.5 For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fittings shall conform to the dimensional standard of ANSI B-16.9.
- However, for pipes upto 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.
- For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
- 27.8.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes upto and including 50 mm NB, i.e. the fitting shall be of seamless construction.
- However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.
- 27.8.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

27.9.00 Flanges

- 27.9.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.
- 27.9.2 All flanges and flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.

27.10.00 Specific technical requirement of laying buried pipe with anti corrosive treatment

The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.

27.10.1 Trenching

- (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822 or any international standard.
- (b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.
- (c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.
- (d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.
- (e) Coating and Wrapping shall be done as under.

27.10.2 Preparation and cleaning of piping

- (a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.
- (b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.
- (c) On the internal surface for pipes 1000 NB and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.
- (d) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

27.10.3 Coating and wrapping/ Anti corrosive Protection Coal tar tape

- a. Buried piping shall be coated and wrapped, as per specification, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are:

- (1) Coating primer (coal tar primer)
- (2) Coating enamel (coal tar enamel)
- (3) Wrapping materials.

All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable.

Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated Kraft outer wrap or finish coat.

Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of Coats and wraps shall be decided based on soil corrosivity/resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available.

Total thickness of completed coating and wrapping shall not be less than 4.0 mm.

- b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS 15337 or equivalent. These-tapes shall be applied hot over the cold coal tar primer in steps of 2 mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm min.

27.10.4 Trench bed preparation and back filling

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

27.10.5 Laying of galvanized steel (GI) pipes

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. Threaded portion on either side of the socket joints shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and "anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

27.11.00 Cleaning and Flushing

- 27.11.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.
- 27.11.2 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.
- 27.11.3 After erection, all water lines shall be hydro tested at 1.5 times the design pressure.
- 27.11.4 All compressed air pipe work shall be cleaned by blowing compressed air.

27.12.00 Painting of Pipes**27.12.1 Buried Piping****Internal surfaces**

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.
- (iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

- (iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

NOTE : CW piping shall be encased in 500 mm thk RCC.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

27.12.2 Overground Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

27.12.3 Other requirements

- (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.
- (b) The color of the finish paint shall be as per approved color-coding.
- (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site.
- (d) The dry film thickness of paint shall not be less than 0.15 mm.

27.12.4 Color code for identification

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

27.13.00 Specification for hangers and supports

27.13.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

27.13.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

- 27.13.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.
- 27.13.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS:226/ or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS:4360. Insulation protection saddles shall be used at support point of all insulated piping.
- 27.13.5 The support shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 27.13.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.
- 27.13.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
- 27.13.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.
- 27.13.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.

27.14.00 Design/Construction/Material Particulars of Gate/Globe/Check Valves/Globe Stop Valve/Butterfly Valve

27.14.1 GENERAL

- (a) All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to operate.
- (b) General requirement of valves are as indicated below:
- (1) The valves as well as all accessories shall be designed for easy disassembly and maintenance.
 - (2) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.
 - (3) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.
 - (4) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.

- (5) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.
- (6) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.
- (7) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.
- (c) The actuator-operated valves shall be designed on the basis of the following:
 - (1) The internal parts shall be suitable to support the pressure caused by the actuators.
 - (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.
 - (3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.
 - (4) All actuators operated valves shall open/close fully within time required by the process.
- (d) Valves coming under the purview of IBR shall meet IBR requirements.
- (e) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:
 - (1) Hand wheel
 - (2) Position indicator (for above 50 mm NB valve size)
 - (3) Draining arrangement wherever required.
- (f) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.
- (g) Check valves shall be used for non-return service. They shall be swing check type or double door (Dual plate) check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening/closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600 mm NB.
- (h) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

- (i) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.
- (j) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.
- (k) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer.
- (l) All valves except those with rising stems shall be provided with continuous mechanical position indicator; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.
- (m) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS-1538 for fitting shall be applicable.

27.14.2 VALVE BODY MATERIAL

Valve body material for various services shall be as follows:

Valve body material for water application like circulating water, Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65 NB and above; gun-metal for sizes 50 NB and below.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water: SS body and disc alongwith SS internals.

Condensate: Cast Carbon Steel/Forged Carbon Steel.

- 27.14.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes and the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504

Rubber seated butterfly valves

BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.
BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves
ANSI B 16.34	Standard for valves
API-594	Standard for Dual-check valves
API-600	Steel gate valves
ANSI-B-16.10	Valves face to face and other relevant dimension
API-598	Valves inspection test

27.14.2.2 End Connections

The end connections, shall comply with the following:

Socket welding (SW) – ANSI B 16.11

Butt Welding (BW) – ANSI B 16.25

Threaded (SC) – ANSI B 2.1

Flanged (FL) – ANSI B 16.5 & AWWA-C-207 (steel flanges), ANSI B 16.1 (Cast Iron flanges)

27.14.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).

27.14.2.4 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.

- 27.14.2.5 All gun metal body valves shall have screwed ends.
- 27.14.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

27.15.00 Check Valves

- 27.15.1 Check valves shall comply with the following characteristics:
- (a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);
 - (b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.
 - (c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.
- 27.15.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.
- 27.15.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.
- 27.15.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

27.16.00 Globe Valves

- 27.16.1 The globe valves shall have the following characteristics;
- Straight conveyed flow
- Right angle
- Preferably, the valves shall be of the vertical stem type.
- 27.16.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.
- 27.16.3 The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.
- 27.16.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

- 27.16.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

27.17.00 Gate valves

All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

27.18.00 Air Release Valve

- (a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.
- (b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.
- (c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS:210 Gr. FG 260 and spindle shall conform to high tensile brass.
- (d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

125# ASA cast iron body, double ball construction air release valve with flanged ends to ASA B 16.10; and bolted cover to release the air. Construction materials shall be as below:

Body, cover	:	Cast iron to IS:210 Gr.FG 260
Bolts	:	Light weight leather/wooden balls
Seats	:	Bronze to ASTM-B-62
Cover packing	:	Braided asbestos
Float	:	Wood/rubber

27.19.00 Butterfly Valves**27.19.1 Design/Construction**

- (a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.
- (1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable.
 - (2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.
 - (3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.
 - (4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.
 - (5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.
 - (6) The operating mechanism shall be mounted directly on or supported from the valve body.
 - (7) All valves shall be complete with:
 - Position indicator (located in a visible place)
 - Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off"

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

27.19.2 Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below:

(a) Cast Iron Butterfly valves

Body & Disc	ASTM A48, Gr. 40 with 2% Ni/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated

Shaft	BS 970 431 S: 291/EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.

Seat ring Seal	18-8 Stainless steel Nitrile Rubber

(b) Stainless Steel Butterfly Valves

Body & Disc	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304

Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/Equivalent

Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) Carbon Steel Butterfly Valves

Body & Disc Shaft	ASTM A 216, Gr. WCB ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Equivalent

Disc & Seat Rings	EPT/BUNA-N/Neoprene

27.19.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.

27.20.00 MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)

(a) The materials shall generally comply with the following:

(1) Cast Steel Valves

Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
Trim.	ASTM A 182 Gr. F6 or Equivalent

(2) Stainless Steel Valves

Body & Bonnet	ASTM A 351 Gr. CF 8M/

ASTM A 182 Gr. 304

Disc -do-

Trim. ASTM 182 Gr. F. 316
/ASTM-A-479 Gr. 316 or Integral
with body**(3) Cast Iron Valves**

Body & bonnet BS 1452 Gr. 14/IS-210 Gr. FG 260

Seating surfaces and rings 13% chromium steel/13% Chrome
overlay

Disc for non-return valves BS 1452 Gr. 14/IS-210 Gr FG 260

Hinge pin for non-return valves AISI 316

Stem for gate globe valves 13% chromium steel or Equivalent

Back Seat 13% chromium steel / 13%
Chrome overlay**(4) Gun Metal Valves**

Body and bonnet IS 318 Gr. 2/Equivalent Standard

Trim -do-

- (b) Cast iron body valves shall have high alloy steel stem and seat.
- (c) Material for counter flanges shall be the same as for the piping.

27.21.00 Float Operated Valves

- (a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.
- (b) **DESIGN AND CONSTRUCTION FEATURES**
The following design and construction feature of the valve shall be the minimum acceptable.
- (c) Valves shall be right-angled or globe pattern.
- (d) Valves shall be balance piston type with float ball.
- (e) Leather liner shall not be provided.
- (f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or Is: 210 Grade 200 or equivalent, and float shall be of copper with epoxy painting of two (2) coats.
- (g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.
- (h) The valves shall have flanged connections.

27.22.00 PAINTING OF VALVES:

Two (2) coats of primer followed by three (3) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of painting shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

27.23.00 RUBBER EXPANSION JOINTS

- 27.23.1 All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
- 27.23.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
- 27.23.3 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
- 27.23.4 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
- 27.23.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
- 27.23.6 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.
- 27.23.7 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.
- 27.23.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
- 27.23.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.

- 27.23.10 The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.
- 27.23.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.
- 27.23.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.
- 27.23.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.
- 27.23.14 Bidder to note that any metallic part which comes in contact with DM / Corrosive water shall be of stainless steel material.

27.24.00 STRAINERS**27.24.1 Simplex type**

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition fitted with a removable plug. The material of construction of various parts shall be as follows:

(a)	Body	IS: 318, Gr. 2 up to 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/ -Body: AISI 316 or equivalent)
(b)	Strainer Element	Stainless steel (AISI 316)
(c)	End connection	Screwed upto 50 mm Nb, and flanged above 50 mm Nb

27.24.2 Duplex type

- (a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.
- (b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

Body	IS: 318, Gr. 2 Up to 50 mm Nb, and IS:210,

Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062
Gr. B and internally epoxy-painted above 50 mm NB.

Strainer element Stainless steel (AISI 316)

End connection Screwed up to 50 mm Nb, and
Flanged above 50 mm Nb.
Gasket shall be of full face type

- (c) The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.
- (d) The size of the strainer and the flow direction will be indicated on the strainer body casting.
- (e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

27.24.3 Three shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited

ANNEXURE-I**SPECIFICATION FOR DUCTILE IRON (DI) PIPES, FITTINGS & SPECIALS****1.00.00 GENERAL**

This specification covers the specific requirement of design, material, manufacture / fabrication, constructional features, inspection & testing, transportation, handling, laying, site testing and annual maintenance contract of Ductile Iron (DI) Pipes, Joints, fittings and specials.

2.00.00 CODES AND STANDARDS

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, "IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification)" or equivalent international standard unless otherwise specified elsewhere in this Technical Specification.

Sl. No.	Code No.	Code Title
1	IS 8329	Centrifugally cast (spun) ductile iron pressure for water, gas and sewage - specification
2	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage - specification
3	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6	IS 11606	Methods of sampling of Cast Iron pipes and fittings
7	IS 455	Portland slag cement
8	IS 12330	Sulphate resisting Portland cement
9	IS 6452	Specification for high alumina cement for structural use
10	IS 6909	Specification for supersulphated cement
11	IS 8112	43 grade ordinary Portland cement
12	IS 1387	General requirements for supply of metallurgical materials
13	IS 1500	Methods for Brinell hardness test for metallic materials
14	IS 1608	Mechanical testing of metals – tensile testing
15	ISO 2531	Ductile iron pipes, fittings, accessories and their joints for water applications
16	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure pipelines – Cement mortar lining
17	ISO 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipelines – Specification for materials

18	ISO 8179	Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer
19	ISO 8179	Ductile iron pipes – External zinc coating – Part 2: Zinc rich paint with finishing layer
20	ISO 8180	Ductile iron pipelines – Polyethylene sleeving for site application
21	ISO 10802	Ductile iron pipelines – Hydrostatic testing after installation
22	ISO 10803	Design method for ductile iron pipes
23	ISO 16132	Ductile iron pipe and fittings – seal coats for cement mortar linings
24	AWWA M 41	Ductile iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying & installation etc.)
25	BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods

3.00.0 DUCTILE IRON (DI) PRESSURE PIPES:

3.01.01 DESIGN REQUIREMENTS

Pipeline shall be sized considering C value as 140 and velocity 2-3m/sec.

3.01.01 Classification:

The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub-section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

3.02.00 Joints:

3.02.01 Generally push-on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent international standard. However mechanical joints, flange joints and restrained joints can also be used.

3.02.02 Rubber gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 or equivalent international standard. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent international standard.

4.00.00 DI FITTINGS & SPECIALS

4.01.0 Design Requirements

4.01.01 Classification

The DI fittings shall be as per IS 9523 or equivalent international standard.

4.02.00 External layer:

The DI fittings supplied shall be provided with external protection of metallic zinc coating or zinc rich paint coating with finishing layer of bituminous paint as per IS 9523 or equivalent international standard.

4.03.00 Internal lining:

The fittings shall be provided with suitable cement mortar internal lining as per IS 9523 or equivalent international standard.

4.04.00 Joints between pipe and fittings:

4.04.01 Generally , Push-on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent international standard. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent international standard.

4.04.02 Rubber gaskets

All the DI fittings shall be provided with rubber gaskets for each socket. Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382/ IS 9523 or equivalent international standard.

Rubber gaskets for use with flanged joints shall conform to IS 638 or equivalent international standard.

5.00.00 TYPE TESTS

5.01.00 The contractor / manufacturer shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract.

5.02.00 The type tests shall be carried out in presence of the Employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

5.03.00 In case the contractor / manufacturer has already conducted such specified type test(s), he may submit the type test reports to the Employer during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise as deemed fit by Employer. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract.

5.04.00 The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

5.05.00 THE FOLLOWING TYPE TESTS SHALL BE CARRIED OUT:

5.05.01 Joint Leak Tightness Test:

- a) Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.
- b) Tests for Leak tightness and mechanical resistance of flanged joints shall be conducted as per ISO 2531.

5.05.02 Cement Lining Smoothness Type Test:

The contractor / manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished to the employer.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the contractor / manufacturer within the scope of this contract.

5.05.03 Ring bend test:

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

6.00.00 LAYING AND JOINTING OF DI PIPES:

6.01.00 Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced / procured.

For underground laying, Special provisions in trench shall be made for accommodating socket (Bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

6.02.00 Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast-in-situ.

7.00.00HYDRAULIC TESTING OF PIPELINES

After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections.

Water and other facilities as required for such hydro testing shall be arranged by the Contractor.

7.01.00 Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere. After filling, the pipeline shall be slightly pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as per the relevant standard. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

7.02.00 Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified in the data sheet attached with this sub-section. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in the data sheet attached with this subsection.

8.00.00 DATA SHEET FOR DI PIPES, FITTINGS & SPECIALS

Sl.No.	Description	Units	Parameters
1	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint.
2	Applicable standards		IS/ISO/AWWA/BS as listed in technical specification
3	Hazen & Wliiam's Constant		140
4	Pipe class		K7/K9 as per IS 8329 or equivalent international standard. Compatible with system pressure requirement.
5	Pipe Joint type		Push-on flexible joints as per IS 8329 / Flanged/ Restraint

6	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS 8329 & IS 9523
7	Welded-on Flange (as applicable) pressure class		Compatible with system pressure requirement.
8	DI fittings class		Compatible with system pressure requirement.
9	DI fittings flange (as applicable) class		PN 25
10	Restrain mechanism at bends, specials etc.		Thrust Blocks
11	Maximum field hydrostatic test pressure	N/mm ²	Shut-off pressure or (operating pressure+surge pressure) whichever is higher for not less than 10 minutes
	At each section (not exceeding 1000m)		
	Complete pipeline		As per IS: 12288 Table-1
12	Other requirements		As per technical specification

33.0 PLANT LAYOUT REQUIREMENT**33.1 Broad Guidelines for Layout Plan**

33.1.1 General layout plan indicating the available spaces for proposed project is as shown in the tender drawing. It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope.

33.1.2 While preparing the detailed layout, planning the facilities in the Bidder's scope and deciding upon the transportation and construction/ erection strategy and functional requirements, the Bidder shall ensure the following aspects:

- a) Face of the buildings and facilities shall be located in such a way so as to have an offset of minimum 20 m with respect to centre line of double lane road and 15 meter with respect to centre line of single lane road. The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations.
- b) The entire construction activity shall take into account the commissioning of the units.
- c) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores is to be managed by the Bidder within the areas available in General Layout Plan.
- d) The finished floor level at ground level of the TG building shall be designated at EL. 0.0M and shall be 500mm above the finished ground level (FGL) of that area.

The finished floor level for various areas / facilities shall be as follows:-

i)	FFL of Main Plant Building	- El. 0.00M
ii)	Top of paving for boiler / ESP area	- EL. (-) 0.20M
iii)	Top of paving for Transformer Yard	- El. (-) 0.10M
iv)	FFL of Mill Bunker building and Chimney	- El. 0.00M
v)	FFL of offsite building	- 500 mm above FGL of respective area
- e) Fuel storage tanks, hydrogen storage complex, etc., shall be designed in accordance with statutory agencies guideline.
 - f) Space provision shall be kept for installation of FGD in future, if required to be installed, as per MoEF requirement.
 - g) All the buildings and facilities shall be approachable by the fire tenders.

- h) Space provision shall be kept for installation of additional field of ESP.
- i) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local by-laws are met.

33.2 Control Room for Offsite facilities

Independent Control room for each of the following off-site facilities shall be provided:

- Water system
- Makeup water system
- Ash handling system
- Coal handling system

However panels for above offsite facilities to be placed in respective CER's near respective off-site control rooms. Further Remote I/O (RIO) rooms shall be provided on as required basis for offsite areas. The exact RIO locations shall be finalised during detailed engineering stage.

Control Rooms / Control Equipment Rooms/ RIO rooms shall be air-conditioned. Batteries for power supply systems as required for RIO rooms shall be placed in a separate ventilated area within RIO rooms.

33.3 Main Plant Layout

Introduction

The proposed location of main plant block is indicated in the general layout plan enclosed with the bid documents however bidder has an option to develop his own layout keeping the location/orientation of the main power block, power evacuation corridor, make-up water corridor, Ash dyke same as indicated in bid document. Bidder shall develop his own layout for the equipment offered and the same to be clearly brought out in the bid. However, while developing the layout the bidder must give due considerations for the following requirements:

- 33.3.1 The unit control room shall be located in the centre of TG building towards boiler side at operating floor level.
- 33.3.2 The unit control room shall be multi level and shall essentially house but not be limited to the followings:
 - i) Unit control panels in control equipment rooms, operator's consoles etc. for all modules. CCR shall not have any internal column inside the room. Large span roof beams for control room to be adopted and designed.
 - ii) Computer room with programmer station & associated consoles and PADO room etc.
 - iii) Electrical control panels, protection panel etc shall be suitably located.

- iv) Conference room and C&I engineer's room.
- v) Shift supervisor room.
- vi) 24V charger, UPS & batteries on unit basis in the control room below unit & common control room & control equipment room at mezzanine floor level.
- vi) Cabling and all other facilities associated with the above system.
- vii) SWAS room at 0.0M in TG building.

33.3.3 The unit control room, computer room with programmer station, PADO room, 24V charger & UPS room, SWAS room shall be located in Air conditioned areas. Washroom/Toilet facilities for ladies & gents separately shall be provided. Further, no vertical bracings, pipes, cable shafts etc. shall be routed through control room or control equipment room area.

33.3.4 The following clearances to be maintained for C&I DDCMIS cabinets:

- i) Inter panel spacing - 1200mm
- ii) Clearance from back - 1000mm
- iii) Clearance from front - 1000mm
- iv) Clearance from side wall - 1000mm

The above clearances are minimum requirement and may increase with increase in door swing of the cabinets.

33.3.5 The cable vault space below the HT / LT switchgear room and Control Room shall have 800 mm wide and 2.1 m high movement passage all around the cable trays in the cable vault/ cable spreader room for easy laying/maintenance of cables.

33.3.6 Operating floor inside the main plant building shall match with top level of TG deck.

33.3.7 Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to:

- 1) Unit and generator transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher.

Oil capacity of individual transformer (in liters)	Clear separating distance (in Meters)
5,000 to 10,000	8.0
10,001 to 20,000	10.0
20,001 to 30,000	12.5
Over 30,001	15.0



- 2) In case of auxiliary transformers having an aggregate oil capacity in excess of 2300 litres but individual oil capacity of less than 5000 liters, the maximum separating distance between transformers and surrounding building shall be at least 6M unless they are separated by fire separating walls or are protected by high velocity spray system.

33.3.8 Layout requirements for Electrical MCC/switchgear rooms

1. The following clearances shall be maintained for HT Switchboard.

a.) Front Clearance

i) For one Row of Swgr	-	2.0M (Min)
ii) For two Rows of Swgr	-	2.5M (Min)
b.) Back Clearance	-	1.5 Meter(Min.)

c.) Side Clearance

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800+width of panel.

2. The following clearances shall be maintained for LT Switchboard.

a.) Front Clearance

i) For one Row of Swgr	-	1.5M (Min)
ii) For two Rows of Swgr	-	1.5/1.75M depending upon room size

b.) Back Clearance

i) For single front	-	1.0M (Min)
ii) For double front	-	1.5M(Min)

c.) Side Clearance

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800 mm + width of panel.

HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same MCC room.

3. Height of HT/LT Switchgear Room

i) With Bus Duct	-	4.5 m (min)
ii) Without Bus Duct	-	4.0 m (min)

33.4 Equipment layout

While developing the layout the Bidder shall ensure the following major layout requirements:



1.	Area of unloading bays	Minimum Two (2) nos. (on either end) of maintenance bays for TG building shall be provided.
2.	Passage way between TG hall And first row of boiler column	12 M
3.	Arrangement of TG set	Longitudinal
4.	Basement, Pits & Trenches	Regular Basement floors are not acceptable in Main Plant Building/Mill Bunker Building.
5.	Clear walkways along A-row & B-row of Power House.	a) 1.5m at all the levels of AB bay, b) 3.0m along B-row at operating floor level for interconnection with service building & in front of control room.
6.	Control Room	Unit control room for unit shall be provided between the unit at operating floor level in B-C bay
7.	Control Equipment Room	Location of Control equipment Room shall be in B-C-Dx-Ex bay at operating floor level & in Dx-Ex bay at mezzanine floor level.
8.	Minimum clear working space Around the equipment	1200mm
9.	Minimum clear working space	1500mm around the Coal mills
10.	Minimum width of all staircase	1200mm
11.	Clear approach width between Boiler & ESP	12m minimum (Height=8M)
12.	Clear approach width between ESP & ID fan	10m minimum (Height=8M)
13.	Clear Head room within Main Plant Building for pipes, ducts, structures & cable trays etc.	2.5m (Minimum)
14.	Clear head room in Passage bay between TG hall And first row of boiler column i.e. CD bay	8m

15.	Shape of Raw Coal Bunkers	Circular
16.	No. of Fire Escape staircases in the main plant with fire doors at each landing.	Min-4 Nos. per unit- However the number shall meet the requirement of insurance companies.
17.	Minimum straight length in flue Gas duct at ESP outlet for Opacity meters	As required for accurate dust measurement within the battery limits.
18.	Coal Mills shall be located either on the side of the boiler or on rear side of the boiler i.e. between boiler and ESP.	
19.	Adequate space and provision for handling/removal of pumps, motors, heaters, heat- exchanger, fans, Mills, Switchgear Panels, Transformers during maintenance shall be provided.	
20	Independent floor drains with separate down comers shall be provided where fire protection system are provided.	
21	In TG bay at crane rail level, chequered plate walkway of minimum 750mm clear width from face of the column to the hand rail on crane side to be provided for entire A-row & B-row column sectional depth for full length of the building.	
22.	Interconnecting walkways (minimum 2.0m clear width) between main plant building and boiler (on either side of boiler) at mezzanine, Operating, PRDS and Deaerator floor level shall be provided. Also interconnecting platform (min. 1.5m clear width) between Boiler and Coal Bunker Building at mill maintenance floor level, Feeder floor level and Tripper floor levels shall be provided by the bidder. Number of interconnecting platform between boiler and coal bunker building for each level/floor specified above shall be two numbers on each side of boiler, i.e. four numbers per floor if the mills are located on the side of the boiler and two numbers per floor if the mills are located on rear side of the boiler.	
23.	Layout of facilities and equipment shall allow removal of Generator Stator, Generator transformers, Station & Unit transformers without disturbing equipments, piping, cabling, ducts routed in the area.	
24.	Valves including actuators and instrument tapings shall be located in accessible positions and operating/maintenance platform for the same shall be provided. All piping shall be routed at a clear height of 2500mm (min.) from the nearest access level to clear man movement.	
25.	Steam turbine and Generator and other equipments located in the turbine hall shall be accessible by the EOT cranes for their handling during erection and maintenance. Wherever special handling procedures are to be followed such as for the generator stator, rotor withdrawal of Generator etc, the same shall be described in written out document and attached with the bid. The offered layout	



of TG Hall shall be such that it shall be feasible to remove the Generator Stator and send it for repair without removal of any equipment located in TG Hall. In case removal/ erection of STG Stator calls for operation of EOT cranes in tandem then the same shall be provided. Further the complete set up including all tools required for removal, assembly & handling of Generator stator shall be provided by the Bidder. In case auxiliaries such as BFP are not in the reach of TG hall EOT crane, then separate EOT crane with proper maintenance area shall be provided along with all tools required for removal, assembly & handling of BFPs.

26. FD, ID and PA fans handling arrangement complete with crane and handling facilities along with removal space shall be provided. A continuous platform shall be provided between fan and motor end for ID/PA/FD fans in order to facilitate movement of personnel.
27. Mill handling arrangement complete with crane and handling facilities along with removal space shall be provided. For each mill bay, bidder shall provide adequate maintenance area for safely handling the mill equipments/parts.
28. Fuel oil (F.O) piping shall be routed over trestles. The headroom for F.O. Trestle in Boiler/ESP area shall be 8.0M till the road behind chimney as per the layout requirement. The headroom for F.O. trestle in outlying area shall be 3.0M except at rail/road crossing where the headroom shall be 8.0M.
29. Routing of cable trays & piping including F. O. piping & ducting-
 - I. Trestle height in outlying area shall be 3.0 M (BOS)
 - II. Trestle height from TG hall to road behind chimney /in front of TFMR yard/ Boiler/ESP area shall be 8.0 M (BOS).
 - III. Cable/Pipe trestles height at rail/road crossings shall be 8M (BOS)
 - IV. The pipes including fire water pipes shall be routed over ground either on pedestals or on trestle in plant area. No trenches for pipes shall be envisaged as far as possible. Wherever fuel oil pipes and steam pipes are running over the trestle, fire water pipes shall not be routed on the same trestle.
 - V. Head room below cable/ pipe rack in transformer yard area for movement of spare GT shall be such that the same can be moved with bushing installed. A clear gap of 500mm between top of bushing and BOS of the trestle shall be ensured.
 - VI. A walkway of 600mm (minimum width) with pipe hand rails & toe guards shall be provided all along length of the trestle for maintenance of cables & pipes. Ladders for approach to these platforms shall be provided near roads, passage ways and turning points. Wherever ash handling pipes are routed



on the trestle, one walkway of 600mm width shall be ensured on the tier meant for routing the ash handling pipes.

- VII. Wherever, dry ash pipes are routed on the top most portion of the pipe/cable trestles, a clear head room of 2.1M over the walkways of dry ash pipe rack shall be ensured.
- VIII. Head room for man movement shall be minimum 2.5m at ground floor in TG and boiler area and 2.1m over all platforms.
- IX. Height of trestles at approach roads to various buildings/facilities shall be 8M. In case building are located in off site area and are adjacent to each other, then as a good engineering practice, the height of trestle shall be maintained all over as 8.0M.
- X. Separate cable tray for optical fiber cable / UTP cable shall be provided.
- XI. The layout shall be developed so as to meet the requirements of the Cabling philosophy indicated separately (Cabling, Earthing & Lightning Protection).
- 30. Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC.
- 31. All cranes shall be provided with approach rung ladders at least at two places. Where ever cranes can't be maintained in situ on the carriage, facility to draw them to maintenance platforms as well as provision of suitable platforms shall be considered by the bidder.
- 32. For Ventilation requirement from A-row side of TG building, space for installation of Air washer units along with pumps shall be considered in AB bay at suitable elevation. No separate room outside A-row for locating Air Washer equipment and no trestle outside A-row for routing Ventilation duct shall be considered. Further, for Ventilation requirement in BC bay, adequate space for installation of Air washer units along with pumps in BC bay for each unit shall be considered. All fresh air ventilation louvers shall be 1000 mm from floor level and directed downward at an angle.
- 33. Separate A/C systems shall be provided for Main plant, ESP Control Room & Service building. For further details relevant section of Technical Specifications may be referred.
- 34. Minimum one (1) number of staircase shall be provided between two adjacent passes of ESP. These staircases shall be equally distributed on the inlet and outlet side of ESP.
- 35. All equipment operating/maintenance platforms at Mill Hoist Level, Mill Discharge Valve level, Bunker/Feeder Outlet Level, Cold and Hot air damper level, scanner approach level, oil gun approach level, approach to bottom of hopper for ash handling and for other equipment shall be provided.

36. All equipment operating maintenance platform including supporting structures such as grating platform in the oil equipment room, control fluid equipment room, valve room, Deaerator, Gland Steam Condenser, Flash tank and for other equipment supplied and erected by the Bidder.
37. Suitable rolling shutters shall be considered in the equipment layout to be developed by the bidder on 'A'-row to facilitate the movement of Generator Transformers, Station & Unit transformers to the maintenance bay. Rolling shutter shall be provided for removal of Condenser tubes. Further rolling shutters at different location shall be provided in TG hall for the movement of material.
38. Ash slurry pipe lines shall be routed on pedestals except at road/rail crossings where pipe culverts shall be provided.
39. A suitable rail track and associated facilities like Jacking pads, mooring posts etc., shall be provided to facilitate the movement of Generator transformers. Station and Unit transformers to the maintenance bay. These rail tracks shall be accessible from the equipment unloading area of TG bay by a rail track.
40. Approach platform shall be provided from ESP outlet to ID fan suction gate.
41. Passenger cum good elevator shall be provided for approach for steam generator, station building, service building, conference room, coal handling TP in SG area, chimney for O&M and Administration building.

33.5 Lay down area for maintenance and overhauling.

1. The layout of the steam turbine units shall permit sufficient lay down area for all the parts/components to enable carrying out maintenance and overhauling operations without any restrictions and without any hindrance to the operating personnel.
2. In case any special arrangement for rotor maintenance is required, the same should be provided.
3. All handling arrangement including any special arrangements like trolley, drive, pedestals etc. for carrying out maintenance and overhauling for steam turbine generator and its auxiliaries shall be provided by the bidder.
4. The Bidder shall furnish general arrangement drawings indicating the equipment lay down area with details such as blocks indicating orientation of dismantled items, travel path etc.
5. The Bidder shall also furnish general arrangement drawings indicating the lay down arrangement of major unit assemblies (provided as spares) in the TG hall with access from EOT crane. If the area provided inside TG building is not sufficient to accommodate these unit assemblies then a separate building shall be provided. The layout and arrangement shall be furnished along with the bids submitted by the bidders.

- 33.6 Local Pits/trenches in Main Plant building are to be avoided. However pits/sumps which are unavoidable such as CW (Circulating Water System) pits etc. shall be provided with required dewatering arrangements by means of drainage pumps and piping up to the nearest drainage network. Bidder shall provide required sump pumps/drainage pumps/submersible pumps & Piping etc.
- Pump shall be permanently fixed in the pits/sumps. If the pit depth is shallow, vertical top mounted sump pumps shall be provided and in deep pits self priming drainage pumps (horizontal type) at floor level or alternatively submersible type pumps may be provided.
- Each pit/sump shall be provided with two numbers (2x100% Capacity) of respective type pumps so that the entire pit is evacuated within 15-20 minutes and the operation of the pumps shall be interlocked through level measurement devices to be installed in the pit/sump so that the pumps shall start automatically and empty the pit.
- The general design and construction features of Vertical sump pumps and Submersible pumps are furnished elsewhere.
- 33.7 Bidder to furnish the detailed erection strategy along with the bid for major equipments located in TG hall, boiler area and ESP area.
- 33.8 Bidder's shall prepare the detailed layout of main power block area indicating the location of all major equipments. The layout shall be furnished along with the bids submitted by the bidder.
- 33.9 In addition to above, layout requirements regarding Coal Handling Plant, Ash Handling Plant and Fuel Oil Handling area buildings, specified elsewhere in the specification shall also be followed.



TITLE :
1X660 MW PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IIB

REV. NO. 00

SUB-SECTION IB - GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)

CHAPTER 17 : AC & DC MOTORS**1.00 MOTORS****1.1 SCOPE**

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

SITE CONDITIONS

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

1.2 Gases, Fumes & Dust Particles

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

1.2.02 Dust Particles

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

2 Indoor Locations.

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

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

1.2.03 Special Fumes

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

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

1.2.04 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.3 LOCATION OF MOTOR - As required

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

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

1.5 TYPE

1.5.1 AC Motors:

- a) Squirrel cage induction motor suitable for direct-on-line starting.
- b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg. C ambient temperature), shall be **Efficiency class-IE2**, conforming to IS 12615, or IEC:60034-30.
- c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

1.5.2 DC Motors Shunt wound.

1.6 VOLTAGE (NOMINAL)

1.6.1 LV Motors

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

1.6.2 MV MOTORS

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

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

1.6.3 HV Motors

For motors above 1500kW - eleven(11) KV

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

1.7 FREQUENCY (NOMINAL) - fifty (50) Hertz

1.8 NUMBER OF PHASES - Three (3)

1.9 SPEED - As required by the driven equipment

1.10 TYPE OF STARTING :

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

1.11 DUTY

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

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

- 1.11.2 All HT motors shall have vibration pads for mounting vibration detectors.
- 1.11.3 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.
- 1.11.4 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.
- 1.11.5 All LV motors rated 0.37kW and higher with S1 duty shall be compulsorily be of energy efficiency level IE 2 as per IS 12615:2011.
- Motors rated above 37kW shall have efficiency higher than 0.92 and high power factor of atleast 0.88.

1.12 **SUPPLY VARIATIONS**

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

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

1.13 **ABNORMAL CONDITIONS CAPABILITY**

Motor shall have following capabilities as specified design ambient temperature:

- 1.13.1 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.
- 1.13.2 Low Voltage Running :
- Motor shall be capable of running satisfactorily at seventy five (75) percent nominal voltage for five (5) minutes.
- 1.13.3 Momentary Low Voltage Withstanding :
- Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

1.14 **STARTING CAPABILITY**

- 1.14.1 Low Voltage Starting :

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

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

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

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

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

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

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

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

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

1.14.5.3 **Starting voltage requirement**

a) All Motors (except Mill Motors)

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

b) For Mill Motors:

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

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

1.14.5.4 **Starting Time**

1.14.5.4.1 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.

1.14.5.4.2 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

1.14.5.4.3 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

1.14.5.5 Torque Requirements:-

- 1.14.5.5.1 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10%. Motor full load torque.
- 1.14.5.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

1.15 SAFE STALL TIME

- 1.15.1 To avoid problem in selecting standard protective relays without using speed switches, safe stall time under hot conditions (corresponding to 110% nominal voltage at motor terminals) shall be more than the accelerating time (corresponding to 80% nominal voltage at motor terminals) by the following minimum values :
- 1.15.1.01 Two (2) seconds, where accelerating time (at 80% nominal voltage) does not exceed 20 seconds.
- 1.15.1.02 Three (3) seconds, where accelerating time (at 80% nominal voltage) exceeds 20 seconds.
- 1.15.1.03 At no stage, speed switch shall be provided to achieve the above requirements mentioned under Clause No. 1.14.5.4

1.16 CLASS OF INSULATION

- 1.16.1 LV Motors Class F.
- 1.16.2 MV & HV Motors Class F
- 1.16.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both HT & LT motors. The temperature under abnormal running conditions shall be limited to 5°C above class 'B' limits.
- 1.16.04 The value of the polarization index for motors above 200kW should not be less than 2 when determined according to IS: 7816.
- 1.17 **TEMPERATURE RISE UNDER NORMAL CONDITIONS.....** Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

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

1.18 BUS TRANSFER WITHSTAND CAPABILITY

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

- 1.18.01 That about 5000 bus transfers, in lifetime of motor, shall not puncture its insulation.
- 1.18.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.
- 1.18.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.
- 1.18.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

1.19 TYPE OF ENCLOSURE

- 1.19.01 Outdoor Motors IP 55 (Additional canopy to be provided by EPC contractor.
- 1.19.02 Indoor Motors IP 55
- 1.19.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.
- 1.19.04 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:
- a) Fuel Oil area : Group IIB
 - b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034).

1.20 METHOD OF COOLING

- 1.20.1 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).
- 1.20.2 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

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

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

prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

1.21.02 Noise level

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

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

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

1.21.05 3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.

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

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm
UP to 3 KW	As per manufacturer's practice.
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331

Above 125 KW-upto 200 KW 203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

1.21.07 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

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

1.21.09 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.

(a)	Below 110KW	:	10.0
(b)	From 110 KW & upto 200 KW	:	9.0
(c)	Above 200 KW & upto 1000KW	:	10.0
(d)	From 1001KW & upto 4000KW	:	9.0
(e)	Above 4000KW	:	6 to 6.5

1.22 WINDING & INSULATION

- (a) Type : Non-hygroscopic, oil resistant, flame resistant
- (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.
- (c) 11kV & 3.3 kV : Thermal class 155 (F) insulation.
AC motors
The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15
- (d) 240VAC, 415V : Thermal Class(B) or better
AC & 220V
DC motors

1.23 DIRECTION OF ROTATION

1.23.1 As needed by driven equipment.

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

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

1.24 BEARINGS



- 1.24.1 General Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 20,000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.
- Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.
- If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.
- Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.
- For MV & HV motors, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.
- When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.
- Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.
- Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.
- Bearings shall be of reputed make subject to the approval of the Owner/Consulting Engineer.
- 1.24.2 Large motors Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.
- 1.25 **SHAFT EXTENSION** Key slotted bare shaft extension of required length with key on driving end.
- 1.26 **DRAIN HOLES** Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.
- 1.27 **LIFTING DEVICES** Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- 1.28 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven

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

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

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

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

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

1.31.1 Temperature rise under normal/abnormal conditions.

1.31.2 Type of bearing and recommended lubricants.

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

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

1.33 **TERMINAL BOXES**

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

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

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

1.33.2 **Main Terminal Box**

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

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

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

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

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

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

Min. fault level for MV Motors - 40 KA

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

1.33.2.5 **PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:**

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	Clearance
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

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

1.34 **TYPE AND SIZE OF CABLES**

1.34.1 **Space Heaters**



- 1.34.1.1 For LV Motors: Two point five (2.5) mm², two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).
- 1.34.1.2 For MV & HV Motors: Six (6) mm² two core aluminium conductor PVC insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- 1.34.2 For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- 1.34.3 Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.
- 1.34.4 For Moisture Detectors.....As for space heaters as per Clause 33.01.01 above.
- 1.34.5 **For Main Terminals**

LT Motors

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

HT Motors

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

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

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

1.35 **EARTHING**

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

- 1.35.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.
- 1.35.03 MV & HV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.
- 1.36 **EMBEDDED TEMPERATURE DETECTORS**.....HT motor shall be provided with six (6) Nos. duplex resistance temperature detectors (RTDs) embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C
- 1.37 **BEARINGS TEMPERATURE INDICATORS**..... HT motors shall be provided with dial type two (2) bearing temperature indicators and will have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set will be set to operate at lower value to give alarm and other set at a higher value to trip the motor.
- 1.38 **SPACE HEATERS**.....Valve / Damper actuator motors; and Motors above 30 KW shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple. Motors upto 30 kW shall have stator windings suitable for connections to 24V, 50 Hz AC supply for space heating.
- Motors upto 30 kW shall have stator windings suitable for connection to 24V, 50 Hz ac supply for space heating
- The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.
- 1.39 **HOT AIR TEMPERATURE DETECTOR**
- If the motor is of CACA or CACW enclosure, a thermometer with alarm contracts in hot air circuit shall be provided.
- 1.40 **WATER FLOW INDICATOR**
- If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.
- 1.41 **MOISTURE DETECTORS**.....Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

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

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

1.44 **TYPE TEST**

1.44.01 **HT MOTORS**

- a) The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract.
- b) The type tests shall be carried out in presence of the Purchaser's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Purchaser's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
- c) In case the contractor has conducted such specified type test(s) within last five years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Purchaser's for waiver of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Purchaser's reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
- d) Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the Purchaser's either at third party lab or in presence of client representative and submit the reports for approval.

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



1 x 660 MW – Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



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

- i) No load saturation and loss curves upto approximately 115% of rated voltage
- ii) Measurement of noise at no load.
- iii) Momentary excess torque test (subject to test bed constraint).
- iv) Full load test(subject to test bed constraint)
- v) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

f) LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of HT motor

- i) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- ii) Terminal box-fault level withstand test for each type of terminal box of HT motors only.
- iii) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15
- iv) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

1.44.02

LT Motors

- a) LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Purchaser's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
- b) However if the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Purchaser's shall conduct all such tests under this contract at no additional cost to the Purchaser either at third party lab or in presence of client representative and submit the reports for approval.

1.44.03

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

1 x 660 MW – Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

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

1.44.04 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

1.45 INFORMATION WITH PROPOSAL

1.45.1 AC Motor Data Sheet.

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

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

1.46.01 Motor Data Sheet.

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

1.46.03 Following characteristics curves:

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

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

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

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

- 1.46.03.05 Efficiency, power factor, current and speed versus power output curves.
- 1.46.03.06 Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- 1.46.03.07 Negative phase sequence current withstand characteristics.

1.47 COMMISSIONING CHECK LIST (HT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box
6. Checking stator (motor air gap) Check – Grease lubrication (for ball or roller bearing) is adequate if the motor was in storage for very long period replace the grease, by fresh grease after flushing the bearing clean. Excess grease in the bearing (housing ... is overheat of bearings) Check the free rotation of the rotor in decoupled condition. Check the air gap between stator and rotor at four positions 90o apart at driving and non-driving end. Compare the recorded values with factory results. For slip ring motors : with starting resistances.
 - a) Check the variation of resistance
 - b) Check brush lifting and slip ring short.

B COMMISSIONING CHECKS

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

1.48 COMMISSIONING CHECK LIST (LT MOTORS)**A PRELIMINARY CHECKS**

Check the following:

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

B COMMISSIONING CHECKS

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

1.49 DC MOTOR SPECIFICATION

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

Contractor will furnish the data in respect of DC motors.

DATASHEET

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

DATA SHEET A		
SL NO.	DESCRIPTION	
		1X660 MW UPRVUNL PANKI TPS.
A	General	
1	Manufacturer & country of origin	DURING DETAILED ENGINEERING
2	Motor type	SQUIREL CAGE INDUCTION MOTOR
3	Efficiency class	IE3
4	Type of starting	DOL
5	Maximum acceptable kW rating of LV motor	200
6	Rating up to which Single phase motors permitted.	
7	Installation (Indoors/ Outdoors)	indoor/outdoor
8	Degree Of Protection	IP55 WITH CANOPY FOR OUTDOOR IP55 FOR INDOOR
9	Name of the equipment driven by motor & Quantity	DURING DETAILED ENGINEERING
10	Maximum Power requirement of driven equipment	DURING DETAILED ENGINEERING
11	Rated speed of Driven Equipment	As per system requirement
12	Design ambient temperature (Degree Celcius)	50 deg C
B	Design and Performance Data	
1	Frame size & type designation	DURING DETAILED ENGINEERING
2	Type of duty	AS PER REQUIREMENT
3	Rated Voltage	240/415 V
4	Rated Frequency	50 Hz
5	System fault level at rated voltage	50kA for 1 sec
6	LV System grounding	solidly grounded
7	Permissible variation for	
a	Voltage	+/-10%
b	Frequency	+/-5%
c	Combined voltage & frequency	10%
8	Rated output at design ambient temp (by resistance method)	as per requirement
9	Synchronous speed & Rated slip	as per requirement

10	Minimum permissible starting voltage	80% of rated voltage
11	TYPE OF STARTER PROVIDED IN MCC	As per system requirement
12	Starting time in sec with mechanism coupled	
a	At rated voltage	As per system requirement
b	At min starting voltage	
13	Locked rotor current as percentage of FLC (including IS tolerance)	The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) (a) Below 110KW : 10.0 (b) From 110 KW & upto 200 KW : 9.0
14	Torque	
a	Starting	a) Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. B) Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
b	Maximum	
15	Permissible temp rise at rated output over ambient temp & method	Thermal class 155 (F) insulation, temperature rise limited to class-B.
16	Noise level in (dB)	85 (dB) at 1 M
17	Amplitude of vibration	As per IS-12075/IEC-60034-14
18	Efficiency & P.F. at rated voltage & frequency	
a	At 100% load	Efficiency as per IS 12615, IEC: 60034-30 (Latest revision), P.F. as per requirement.
b	At 75% load	

c	At starting	Efficiency as per IS 12615, IEC: 60034-30 (Latest revision), P.F in line with starting requirement as per relevant standard.
C	Constructional Features	
1	Method of connection of motor driven equipment	As per system requirement
2	Applicable Standard	as per relevant standard
3	DOP of Enclosure	IP55 WITH CANOPY FOR OUTDOOR IP55 FOR INDOOR
4	Method of cooling	IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA).
5	Class of insulation	All motors shall have class F insulation but limited to class B temperature rise
6	Main terminal box	
a	Type	Refer Specific technical requirement for motors
b	Power Cable details (Conductor, size, armour/unarmour)	1.1 kV XLPE armour cable, size shall be provided during detailed engineering
c	Cable Gland & lugs details (Size, type & material)	Refer Specific technical requirement for motors
d	Permissible Fault level (kArms & duration in sec)	
e	Degree of Protection	
7	Earth Conductor Size & Material	Refer Specific technical requirement for motors
8	Space heater details (30KW & ABOVE) (Voltage & watts)	Refer Specific technical requirement for motors
9	Flame proof motor details (if applicable)	During detailed engineering
a	Enclosure	
b	suitability for hazardous area	
i	Zone O / I / II	
ii	Group IIA / IIB / IIC	
c	Degree of Protection	
9	No. of Stator winding	As per system requirement
10	Winding connection	As per system requirement
11	Kind of rotor winding	As per system requirement
12	Kind of bearings	Refer Specific technical requirement for motors
13	Direction of rotation when viewed from NDE	Motor shall be bi-directional
14	Paint Shade & type	Glossy light grey finish no 631 of IS 5, for details refer Specific technical requirement for motors
15	Net weight of motor	DURING DETAILED ENGINEERING

16	Outline mounting drawing No (To be enclosed as annexure)	DURING DETAILED ENGINEERING
D	Characteristic curves/ drawings	
1	(To be enclosed for motors of rating >55KW)	DURING DETAILED ENGINEERING
2	Torque speed characteristic	
3	Thermal withstand characteristic	
4	Current vs time	
5	Speed vs time	
E	Tests on motors	As applicable (As per QAP/For Project specific requirement if any refer Specific technical requirement for motors)

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 29/05/2019
		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			

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 29/05/2019
		SHEET 2 OF 2

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 $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : I

SUB-SECTION:IIC

REV. NO. 00

SECTION – IIC

GENERAL TECHNICAL REQUIREMENT (CONTROL AND INSTRUMENTATION)

CHAPTER-2: FIELD AND MEASURING INSTRUMENTS**2.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)**

- 2.00.01 Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section/chapter 1, Vol. V, Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to Owner's approval.
- 2.00.02 Every panel-mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
- 2.00.03 All transmitters, sensors, and switches, Gauges for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided on as required basis with in quoted lump sum price. The Bidder shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Owner during detailed engineering.
- 2.00.04 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. **Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.**
- 2.00.05 **For corrosive applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by bidder).**
- All instruments shall be provided with **durable epoxy coating for housings** and all exposed surfaces of the instruments.
- 2.00.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. **The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified** (Explosion proof for NEC article 500, class 1/2, Division 1 area & Flame proof area) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



In general, double cable entry shall be provided, wherever available, unused cable entry shall be provided with blind metal plug. All the field instruments shall also be provided with SS tag nameplate. Counter and mating flange (SS316 material), fastener, gaskets, Nuts, bolts etc. shall also be included wherever required with the field instruments.

- 2.00.07 In general, front draw out type instruments with plug-in facility at the rear for connecting cables for power supply and signal shall be provided unless otherwise specified like for Explosion proof area, Flame proof area and high vibration prone area. Separate plugs & socket connection shall be provided for connecting power supply cables and signal cables.

The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands (Material as decided by owner) for Explosion proof area, Flame proof area and high vibration prone area.

- 2.00.08 The quantity of secondary instruments etc. to be provided by Bidder shall be adequate to meet the requirements of Technical Specifications. Any other additional quantity of secondary instruments envisaged by Bidder as per system and process requirements shall also be supplied without any cost implication.

2.01.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

2.01.01 SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF. PRESSURE AND DP BASED FLOW, LEVEL MEASUREMENTS

Sl. No.	Features	Essential/Minimum Requirements
1	Type of Transmitter	Microprocessor based 2 wire type, Hart protocol compatible
2	Accuracy	± 0.1% of calibrated span (minimum) (upto turn down ratio of 10:1).
3	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4	Turn down ratio	10:1 for vacuum/very low pressure applications. 5:1 for very high pressure application. 30:1 for other applications.
5	Stability	± 0.1% of calibrated span for six months for Ranges up to and including 70Kg/cm ² . ± 0.25% of calibrated span for six months for Ranges more than 70Kg/cm ² .
6	Zero and span drift	+/- 0.015% per deg.C at max span.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		+/- 0.011% per deg.C at min. span.
7	Load impedance	500 ohm (min.)
8	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9	Over Pressure	150% of max. Operating pressure.
10	Connection (Electrical)	Plug and socket type
11	Process connection	1/2 inch NPT (F)
12	Span and Zero	Continuous, tamper proof, Remote as well as adjustability manual from instrument with zero suppression and elevation facility
13	Material	Die cast Aluminum with epoxy coating/SS316 for body. SS316 for Diaphragm.
14	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. - LCD/TFT digital integral Indicators with scale of Engg. Units. -2 valve SS316 manifold for absolute & Gauge pressure transmitters, 3-valve SS316 manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve SS316 manifold for DP/Level/Flow applicable. Transmitters should not be mounted directly on the manifold; Manifold shall be non integral type only. - Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. -For hazardous area, explosions proof enclosure as described in NEC article 500.
15	Diagnostics	Self Indicating feature
16	Power supply	24V DC $\pm$ 10%.
17	Adjustment/calibration From hand held calibrator/centralized OWS based system n/maintenance (as applicable).	From hand held calibrator/centralized OWS based system

Notes

For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.

LVDT type is not acceptable.

Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2.02.00 Specification for Pressure Gauge, D.P Gauge, Temperature Gauge and Level Gauge

s. no.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	Temperature gauge	Level Gauge
1	Sensing Element and Material	Bourdon for high pressure, Diaphragm/ Bellow for Low pr. Of SS 316	Mercury in Steel/Bimetallic type for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body Material	Die Cast Aluminum with stoved enamel black finish /SS316	Die Cast Aluminum with stoved enamel black finish /SS316	Forged carbon steel/SS 304
3	Dial Size	150 mm with toughened shatter proof glass	150 mm with toughened shatter proof glass	Tubular covering entire range
4	End Connection	½ inch NPT (M)	¾" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	+/- 1% span	+/- 1% span	+/- 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range Selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



8	Over range test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C		
9	Housing	Weather and dust proof as per IP-65	Weather and dust proof as per IP-65	CS/304 SS leak proof.
10	Zero/span Adjustment	Provided	Provided	-
11	Identification	Engraved with service legend or laminated phenolic name plate		
12	Accessories	Blow out Disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS316 Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of steel/SS as per CS/ alloy process requirement.
13	Material of Bourdon/ movement	SS 316	SS 316	

Notes – *Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with inert liquid suitable for the application.

2.03.00 GUIDED WAVE RADAR TYPE LEVEL TRANSMITTER

Guided wave radar type level transmitters shall be provided for level measurements of the vessel under vacuum or low pressure applications as specified in Part-A.	
Type	Guided wave Radar
Principle	TDR (Time domain reflectrometry)
Probe Type & Material	Coaxial, SS316/316L. If required, probe shall be suitable for overfill prevention.
Connection type and material	Flanged and SS316/316L.
Signal o/p	4-20mA with HART signal suitable for overfill prevention.
Display	Integral
Power supply	24 VDC



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Accuracy	5mm
Electromagnetic compatibility	Shall meet EN 61326-1 (1997) and AmdtA1, class A equipment/EN 50081-2 & EN 50082-2
Housing material	Die cast Aluminum/SS316.
Vent & Drain Plug material	SS 316
Local Display	LCD digital type, configured in engg. Units.
Accessories	Integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate and metal tag. All material of accessories will be SS 316.
Mounting	External cage mounting
The transmitters shall be provided with IP-65 protection class with durable corrosion resistant coating. The transmitters shall be able to provide digital signals super imposed on 4-20 mA signal as per HART protocol.	

2.04.00 Ultrasonic Type level Transmitter

Sl.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter. Also refer note-3.
2.	Output signal	4-20mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3mm or better
5.	Power supply	24 V DC +/-10%
6.	Temperature compensation	To be provided within transducer
7.	Configuration	
8.	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9.	Adjustment/Calibration/maintenance	From hand held calibrators/ centralized OWS HART based system (as applicable)
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It shall be possible to calibrate the instrument without any level in the tank/sump etc.

11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry
13.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc.
14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum.
17.	Electrical Connection	Plug and socket.
18.	Accessories	- All weather canopy for protection from direct sunlight and direct rain. - All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. For hazardous area, explosion proof enclosure as described in NEC article 500.
Note:- 1) Bidder can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Owner during detailed Engineering. 2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacture. 3) Four wire type transmitters can also be provided subject to Owner's approval during detailed engineering stage. However, in such cases isolated 4-20mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 24V DC for main plant and CW system applications. Power supply can be 240V AC (UPS) / 24V DC for other application.		



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	4) Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided by owner during detailed engineering. Separate Sensor unit & electronics unit with LCD display to be provided for the applications, which will be decided during detailed engineering by owner.

2.05.00 HART Hand Held calibrator

Hand held calibrator shall be provided for adjustment/calibration/maintenance of the HART compatible transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

HART hand held calibrator shall be provided with following minimum accessories per set:-

- i. Soft carrying case with adjustable shoulder straps & lead compartments.
- ii. HART lead set.
- iii. Rechargeable batteries.
- iv. Battery charger.
- v. Power adaptor.
- vi. Universal plug kit for power adaptor.
- vii. Load resistor.
- viii. Interfacing cables of each type as per requirements.
- ix. Protective boot.
- x. Standard banana jack.
- xi. Operation manual & software CD.

The quantity of HART hand held calibrator to be provided by Bidder is listed in Appendix- I to Vol.V, Table IV, Part A of Technical Specifications.

2.06.00 Temperature Elements and accessories**2.06.01 Thermocouples**

S.No.	Features	Essential/Minimum Requirements
1.	Type of Thermocouple	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type S/R) depending on operating temperature Range (ungrounded type).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Die cast Aluminum. Head of TE to be provided with sufficient space and arrangement to head



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of Thermocouple	Swaged type magnesium oxide insulation
5.	Calibration and accuracy	As per IEC-751/ANSI-C-96.1(special class) for T/C
6.	Characteristic	Linear with respect to temp, within $\pm 1/2$ percent of top range value
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8.	Standard	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
10.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
11.	Instrument Connection	1/2 " NPT (F).
12.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
13.	Enclosure Class	IP-65 or better.
14.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
15.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

Notes

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

2. Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.
3. The specification for thermocouples of bearings metal and winding temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However type of thermocouples shall be K-type.

2.06.02 Resistance Temperature Detector (RTD)

S.No.	Features	Essential/Minimum Requirements
1.	Type of RTD	Four /Three wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of RTD	Metal sheathed, ceramic packed
5.	Calibration and accuracy	As per DIN-43760/IEC 60751 Class-A for RTD
6.	Characteristic	Linear with respect to temp, within $\pm 1/2$ percent of top range value.
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well
8.	Standard	DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	Sheath O D	8 mm.
	Gauge	18 SWG
10.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
11.	Instrument Connection	1/2 " NPT (F).
12.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
13.	Enclosure Class	IP-65 or better.
14.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
15.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

NOTES:

- 1) The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be PT100.

2.06.03 Metal Temperature Thermocouples

S.No.	Features	Essential/Minimum Requirements
1.	Measuring Medium	Metal Temperature
2.	Material of Thermocouple	Chromel Alumel Type K
3.	Type of Thermocouple	Duplex with separate hot junctions, ungrounded Insulation Mineral Insulation Magnesium Oxide.
4.	Thermocouple wire gauge	16 AWG
5.	Protective sheath	SS 321
6.	Protective sheath dia	8 mm O.D
7.	Characteristics of Thermocouple	Special limits of error as in ANSI thermocouple MC 96.01, 1975
8.	Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		or as per OEM design
9.	Cold end sealing	SS pot weld with colour coded PTFE headed sleeve Insulated flexible tails. Sealing compound- Epoxy resin
10.	Minimum bending radius	30 mm
11.	Length of T/C	30 Mtr. (minimum)

Notes:

- 1) The specification for thermocouples of bearings metal and winding temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However type of thermocouples shall be K-type.
- 2) For boiler metal temperature applications considering the location of installation and response time, manufacturers standard and proven specification for metal temperature measurement can also be a accepted subject to OWNER approval. The manufactures shall submit adequate supporting documents for establishing their standard and proven practice.

2.06.04 Thermo well (for all process temp. elements) - (As per ASME PTC 19.3, latest edition)

- a. Shall be one piece solid bored type of 316 SS/F11/F22/F91 of step-less tapered design for water and steam Services depending upon process parameters.
- b. For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.
- c. For Air & Flue gas 316 SS protecting tube with welded cap. (However bidder shall provide better material for Flue gas service if required based on the specified boiler design parameters).
- d. For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.
- e. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 (latest edition).

"All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells".

2.06.04 Void

2.06.05 TEST THERMOWELLS (TW)



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection		
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with SS chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

2.07.00 TEMPERATURE TRANSMITTER

Following types of 2-wire temperature transmitter (directly powered from 4-20mA input cards of DDCMIS/PLC) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the bidder as well as Owner. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a. Single Input Head mounted Temperature Transmitter

These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. Single Input DIN-rail mounted Temperature Transmitter

These shall be suitable for mounting on DIN-rails in JB's. The specifications of the JB's shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail.

Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. Dual-input Temperature Transmitter with Indicator:



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



These shall be suitable for mounting on pipes/ support. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails. This change-over is to be alarmed. Protection class shall be IP65 minimum.

The exact applications for which this type of transmitter is to be provided shall be finalized by owner during detailed engineering.

d. Common requirements for each of the above type of temperature transmitters.

Output	:	2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
Input	:	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K&R types (input type to be selectable at site through HART terminal)
Isolation	:	Min. 500 V AC
EMC compatibility	:	as per EN 61326
Operating ambient temperature	:	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
Power supply	:	Compatible with input module of Control System
Accessories	:	Mounting arrangements including Clamps etc.
Composite Accuracy	:	(a) For head mounted and DIN-rail mounted type Refer note-2 RTD = <0.4% of 0-250 deg C span T/C-K type = <0.4% of 0-600 deg C span T/C-R type = <0.4% of 0-1000 deg C span

(b)	For dual-input type:
RTD	= <0.25% of 0-250 deg C span
T/C-K type	= <0.2% of 0-600 deg C span

e. Field bus compatible temperature transmitters

Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc directly from the transmitter. **Maximum Number of inputs per such temperature transmitter shall be eight.** These shall be mounted in cabinets in non-AC areas.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.

Notes (Common for a to e above):-

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.

2.08.00 IMPACT HEAD TYPE FLOW ELEMENT

The impact head type element shall be tubular insert type with four impact ports facing upstream direction, located precisely for determination of average flow velocity and shall be of SS 316 L.

Accuracy shall be 1.0% of actual value or better. Repeatability shall be $\pm 0.1\%$ of actual value or better.

The elements shall be supplied complete with mounting hardware; end support plugs and SS316 valve manifold (1/2" NPT connection) for instrument connections. All pertinent data including Owner's instrument tag no. for the flow element shall be punched on a stainless steel plate and affixed to the element.

Flushing arrangement shall be provided.

Dual path transit time clamp-on Ultrasonic Flow meter may also be used for measurement of CW flow.

2.09.00 FLUE GAS ANALYSER

The following flue Gas analyzers are envisaged:-

- i) Flue Gas analyzers for control and monitoring – quantities as indicated in Vol. V, Appendix I, Sr. no. G1, Part A.
- ii) Flue Gas Dust Emission analyzer for each ESP (at each Path) – quantities as indicated in Vol. V, Appendix I, Sr. no. G1, Part A.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Each analyser shall be independent and shall not share power supply, processor etc. with other analyser except compressor for purging air. The common requirements to be met for all types of analysers are as below. The specific requirements to be met by each type of analyser are detailed in the subsequent clauses.

2.09.01 Common Requirements for all Analysers:-

S.No.	Features	Essential/Minimum Requirements
1	Output signals	
	Analog	4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall also be connected to OWS/PC based station.
	Binary	2 NO + 2 NC for high alarm
2	Zero & span Adjustment	To be provided with range selection facility.
3	Ambient temp.	50°C
4	Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
5	Enclosure Type/Material	Weather & Dust proof (IP 65) Die cast Aluminium/SS.
6	Type of Electronics	Microprocessor based with self diagnostic.
7	Digital Signal transmission	HART/RS 485 Port Modbus Protocol/Ethernet TCP/IP protocol.
8	Calibration	Auto & Manual (from Remote)
9	Power Supply	To be arranged by Bidder subject to Owner's approval.
10.	Others	I) All interconnection tubing and cabling between probe and analyser / analyser panel and cabling from analyser/ analyser panel to DDCMIS (in central control room) & OWS/PC station are to be provided by Bidder.
		ii) All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.
11	Location of probe	High temp O2 –SH zone Low temp O2:- ECO outlet, AH outlet and ID inlet. Dust emission analyser – In each ESP gas stream/path
12	Compliance to standards	USEPA, TUV, MCERTS or equivalent standards
13	Type of Technology	Dust emission analyser – Opacity In situ (Path)type/ Tribo Electric Induction method In situ type



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



		Low temp O2 & High temp O2-Insitu type

2.09.02 Low temp O2 and High temp O2 Analyser cum monitor:-

Specification Requirements system	Oxygen Analyser cum Monitor (High Temp.)	Low temperature O2 Analyser cum monitor
Type of instrument	Non-heated in-situ dry type	Heated type in-situ
Principle of Measurement	Partial-pressure using Zirconium Oxide Cell	Partial-pressure using zirconium oxide cell
Measurement Range	0.01% to 10% oxygen	0 to 25% oxygen programmable up to min 0.5% of O ₂
Accuracy	+/-1% of F.S. or 0.5 % O ₂ , whichever is more	+/-1% of Full Scale
Linearity	± 1% of F.S.	± 1% of F.S.
Repeatability	≤ 0.5% of span	≤ 0.5% of span
Response time(up to 90% of full scale)	≤ 5 secs	≤ 5 secs
a) Temperature Drift	-	-
b) Zero Drift	-	< 1% span/week
c) Span Drift	Stability:- 1% deviation throughout life of sensor	< 1% measured value/week
Operating Temperature Range	600-1600 deg. C	0-450 deg. C
Filter	Cell shall be protected using ceramic boot	Suitable filter to be provided
Accessories system purging	Not applicable	Not applicable
Temperature	Yes With R/B type thermocouples (to be finalised during detailed Engineering) required.	Automatic temperature control of heating circuit through thermostat

Note: 01. For O2 Analyzer, the construction of the sensor shall be such that joints between dissimilar materials are avoided to prevent formation of cracks.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

2.11.02 E-P CONVERTER

E-P converters and associated accessories shall be furnished in accordance with the specifications given below:

Air supply: 1.5 kg/cm sq., Input signal: 4-20mA dc (as required by the design of control system), Output signal: 0.2 to 1.0 kg/cm sq., Linearity: 0.5% of span or better, Hysteresis: 0.5% of span or better, Ambient Temperature Effect: less than 0.02% of span per deg C between -20 to +60 deg C. Mounting: Close to actuator (but not on the actuator), output capacity to suit the actuator, protection class IP 65. On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition without any additional solenoid valve. The allowable drift rate will be +2% of set point/ hour maximum. Material of accessories will be SS. E/P converters shall have fail freeze (stay put) feature also. Zero/span adjustment facility shall be provided.

2.12.00 SPECIFICATION FOR FLOW ELEMENTS & FLOW METERS

2.12.01 Orifice Plate

Sr No.	Features	Essential/Minimum Requirements
1	Features	Essential/Minimum Requirements
2	Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042, ISO 5167
3	Material	316 SS
4	Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe dia above 300 mm.
5	Material of branch pipe	Same as main pipe
6	Root valve type	Globe
7	Root valve material	316 SS
8	Root valve size	1 / 2 inch or 1 inch (as applicable)
9	Impulse pipe of same material up to root valve	Required
10	Tapping	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
11	Beta Ratio	0.34 to 0.7
12	Beta Ratio	Yes



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	calculation to be submitted	
13	Assembly drg. and flow Vs DP Curves	Yes
14	Accessories	Root valves, flanges, Vent/drain hole (As required)
Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations		

2.12.02 Flow Nozzle

Sr No.	Features	Essential/Minimum Requirements
1.	Type	Long radius, welded type as per ASME PTC- 19.5 (Part-III) or BS-1042
2	Material	316 SS
3	Thickness	Suitable for intended application.
4	Material of branch pipe	Same as main pipe
5	Root valve type	Globe
6	Root valve material	316 SS
7	Root valve size	1 inch
8	Impulse pipe of same material up to root valve	Required
9	Tappings	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable).
10	Beta Ratio	Around 0.7
11	Beta Ratio calculation to be submitted	Yes
12	Assembly drg. and flow Vs DP Curves	Yes
13	Accessories	Root valves, vent and drain hole.
Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations		

2.12.03 ROTAMETERS

Sr No.	Features	Essential/Minimum Requirements



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



1	Type	Variable Area Metal Tube
2	Fluid media	Water/oil
3	Tube body	SS316
4	Material of float	316 SS
5	Indicator	Linear scale
6	Accessories	Flange, orifice in case of bypass Rota meter (for line size above 100 mm)
7	Housing protection class	IP-65
8	Accuracy	$\pm 2\%$ of measured value

2.12.04 POSITIVE DISPLACEMENT TYPE FLOW TRANSMITTERS

The meter shall be a volumetric meter type consisting of two meshing oval wheels driven by the fluid. Each revolution of the oval wheels shall displace a precisely known volume of the fluid from inlet to outlet. The housing/measuring chamber and oval wheels shall be of 316 SS. Air eliminators shall also be provided to ensure maximum accuracy.

The measurement accuracy of the transmitter shall be better than $\pm 0.2\%$.

The transmitter shall provide suitable 4-20mA dc output signal for control and indication/recording. Converters if necessary shall be provided to generate the 4-20mA signal.

A local indicator of fuel oil flow shall also be provided. The instrument shall be calibrated in Tons/hr.

Suitable strainer shall be provided before the transmitter for the protection of oval wheel meters against foreign matter contained in the fuel oil.

The exact model no. and type of material being used, etc., shall be subject to Owner's approval during detailed engineering without any price repercussion to Owner.

2.12.05 DUAL PATH TRANSIT TIME CLAMP-ON ULTRASONIC FLOW METER

The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to owner's approval.

All accessories required for mounting/erection of this instrument shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.

Flow meters shall be provided with suitable environment protection devices/structures such that they shall be suitable for continuous operation in the



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

TECHNICAL REQUIREMENTS

Type	Transit time Clamp On Ultrasonic meter
Mounting Style	Dual path with two sets of transducers on the same pipe
Flow measurement	Instantaneous Flow rate as well as totalized flow
Power supply	230 V AC from UPS.
Outputs: Analog Current Binary	Isolated 4-20mA linear outputs for each path Contact relay outputs, 2 NO + 2 NC for alarm
Communication ports	RS 232 C digital Hand held terminal port
Display/Indication	Flow meter with LCD screen backlight based local display and keypad If required, transmitter shall be suitably located away from the sensor for better access and visibility.
Recording / Totalizing/Logging Facilities	Yes. Should be able to compute cumulative flow over intervals selectable by owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future
Software features	Compensation for any cross path errors. Programming, configuration, shall be possible from front panel.
Diagnostics	False signal tolerance , power supply failure etc
Protection class	IP-65 'or better, Weather protection against direct sunlight, rain etc for Flow .' meter and suitable for Cooling water for Transducer
Accuracy	+/- 1%
Electrical connection	Plug and socket
Pipe location	Underground
Accessories	All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS 316.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



integrator convert this signal into time based flow rate indication & provide totalized flow also.

Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67)/ Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Class		
Accuracy	:	+/-1% of measured value.
Repeatability	:	+/- 0.1%
Drift	:	Both zero & span + 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication (HART) facility	:	yes
Power supply	:	230 V AC, 50Hz. UPS
Ambient condition	:	Temperature -600 C, RH-95% Environment – Highly Dusty
Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. whichever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

2.13.00 PROCESS ACTUATED SWITCHES

Sr No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	Temperature switches	Level switches
1	Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (10 m minimum)	Capacitance types for oil and dirty medium, water, condensate application. Float type for applications as



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



				decided by owner during detailed engineering. Capacitance/Conductivity/Ultrasonic type for acid and alkali application. RF/ Ultrasonic type for ash hopper, ash slurry application. Detailed spec are also included below.
2	Material of sensing element & movement.	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
3	End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
4	Over range proof pressure	150% of max. design pr	-	150% of max. design pressure
5	Repeatability	± 0.5% of full range		
6	No. of contacts	2 Nos. +2NC. SPDT snap action dry contact. Auto reset with internal Adjustable snap action micro switch.		
7	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS/PLC)		
8	Elect. Connection	Plug in socket		
9	Set point	Provided over full range. Differential shall be adjustable.		
10	Dead band adjustment	Adjustment upto 10% at set points.		
11	Enclosure	Die cast Aluminum with stoved enamel black finish/SS316, Weather and dust proof as per IP-65. Epoxy painting shall be provided for corrosive atmosphere.		
12	Accessories	Siphon, snubber, chemical, pulsation dampers as required by process.	Thermo well of 316 SS and packing glands	All mounting accessories
13	Mounting	Suitable for enclosure/rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
14	Power Supply (wherever	24 V DC, to be arranged by Bidder except for Ash Level Switches, where the same shall be as per Bidder's Standard practice.		

Accessories : Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

2.13.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

1. Input Supply : 230 V AC from UPS
2. Construction : Cast Aluminum Housing
3. Relay Output : 2 Nos. Relay Changeover Potential Free Contacts (2 SPDT)
4. Contact Rating : 5A at 240 V AC & 0.25 at 220 V DC
5. Class of Protection : IP-66
6. Ambient Temperature: 55 Deg. C (Max)
7. Local Indication : Local LED Indications
 - Green : Normal Level
 - Red : Alarm Level
 - Yellow : Probe Healthy
8. Cable Connection : 3/4" ET (2 Nos.) for Supply and Output
5/8" ET (1 No.) for Probe Connection
9. Repeatability : 100%

B. Sensing Probe

1. Type of Probe : Rigid
2. Material : Stainless steel SS 316
3. Probe Head Housing : Cast Aluminum
4. Insulation (B/W Active & Shield And Shield & Ground) : PTFE
5. Probe Head Protection : IP-66
6. Mounting : Side Mounted
7. Cable Connection : 5/8" ET (1No.)
8. Process Connection : 40 NB BSP THREADED

C. Signal Cable : Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Mtrs. Per Level Probe)

D. Application : Silos

2.14.00 SOLENOID VALVES

Solenoid valves shall fulfill the following requirements:



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- a. Type 2/3/4 way with body material of SS 316/Forged Brass and epoxy painting (depending on the application subject to Owner's approval during detailed Engg.). Material of Wetted parts shall be SS316.
- b. Power supply 24 V DC + 10%.
- c. Plug and socket electrical connection.
- d. Insulation: Class 'H'.
- e. All solenoid shall be with, LED indication, surge suppression diode circuits.

2.15.00 Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting).
	:	b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm ² .
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Hysteresis : Less than $\pm 1\%$ of full travel.

2.16.00 WATER SYSTEM RELATED SPECIAL INSTRUMENTS (CW plant, D M PLANT, CPU PLANT, PT PLANT, AWRS, Service water, Potable water, etc.)

2.16.01 ANALYSER INSTRUMENTS:

For Technical specification of Cation/Specific Conductivity, pH, Sodium, Silica, Turbidity, Total Dissolved Solids (TDS) and Concentration analysers, and other requirements, please refer Specification of Analysers, Vol.-V, Part A and Part-B, chapter 5, SWAS chapter of this specification.

2.16.02 Residual Chlorine Analyser

- (a) An automatic chlorine residual analyser of amperometric type shall be provided alongwith the chlorinating plant for monitoring the residual chlorine content of cooling water. The analyser shall be suitable for accurate residual measurement in open/closed systems. The measurement accuracy shall not be affected by presence of treatment chemicals as chromates, phosphates, de-former highly polluted water, change in temperature etc.
- (b) The analyser shall comply with the following specification requirements, as a minimum
- | | | |
|--------|--------------------|--|
| (i) | Indicator | : Provision of LC display in the panel of analyser. |
| (ii) | Range | : 0 to 20.0 mg/L (ppm) |
| (iii) | Accuracy | : 2% or better |
| (iv) | Sensitivity | : 0.01 mg/1 |
| (v) | Output signal | : 4-20mA DC isolated output |
| (vi) | Alarm annunciation | : High and low alarms to be provided on panel and shall be field adjustable |
| (vii) | Calibration | : Zero and span adjustment facility to be provided. Final calibration adjustments of the analyser to be done at site and duly verified by titration. Temperature compensation range 0 to 50degC. |
| (viii) | Mounting | : The analyser shall be suitable for field mounting conform to protection class IP-65. |
| (ix) | Electrodes | : Platinum/Gold and copper electrodes shall be provided with cell cleaning system. |
| (x) | Power Supply | : 230 V AC, +/- 10%, 50 Hz. From UPS |
- (c) Circulating water as sample to residual chlorine analyser shall be taken from hot circulating water pipe work before entry to cooling towers. Exact location and layout of sampling arrangement shall be finalised during detailed engg. stage. Bidder shall provide necessary pumping system (with 100% standby) for meeting the analyser requirements, if needed. All the

drains shall be terminated up to the nearest plant drainage system.

2.16.03 All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack so that the equipments are protected against rain/ sunlight etc.

2.16.04 Parshall Flume

The Bidder shall provide all the control and Instrument devices including primary sensors, transmitters, flow indicator cum integrator / totaliser and shall include all required accessories for the flow measurement of raw water through the clarifier. The system shall be of reputed make and acceptable to the owner.

Level measurement shall be based on ultrasonic/radon technology. The flow compensation is to be implemented in the transmitter itself. The transmitter shall provide 4-20 mA DC in direct proportion to flow and shall be able to drive a load impedance of 500 ohms minimum

Accuracy shall be +/- 1 % or better.

All the mounting hardware and accessories required for erection and commissioning of the same are to be provided by the bidder. Mounting fittings material shall be SS316. All weather canopy is to be provided for electronics/sensor to protect the same from rain/ sunlight etc.

The Type makes and models no. shall be subject to Owner's approval.

2.16.05 Electronic Flow-Meter

The electronic flow meter shall include flow sensor and flow indicator cum integrator / totaliser and shall include all required accessories for satisfactory operation. The flow meter shall be based on full bore ultrasonic / electromagnetic principle and shall be electronic type of proven design, make and model acceptable to the owner.

The Bidder shall submit all necessary technical literature and details of selection criteria of the instrument offered to substantiate the model selected. The Bidder shall also furnish list of similar installation along with feed back on satisfactory performance of the instruments.

The flow meter shall meet or exceed the following requirement:

(a)	Output	4-20 mA DC Isolated output HART compatible
(b)	Accuracy	± 0.5% of calibrated span or better *
(c)	Repeatability	± 0.2% of calibrated span or better
(d)	Ambient Temp. &	4 deg.C to 55 deg.C.
	Humidity	5% to 100% RH



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



(e)	Power Supply	UPS 240V AC $\pm$ 10%, 50 HZ $\pm$ 5%/ 24 V DC, to be arranged by the bidder.
(f)	Protection class	IP-65
(g)	flange material, Measuring tube & electrode material	SS 316
(h)	Liner material.	Teflon.
(i)	Features	zero stability, zero and span field adjustable, suitable for process medium with $\leq$ 5 micron Siemens conductivity.

The flow meter shall provide local indication for instantaneous flow. It should also be possible to get local display for daily and monthly discharge. The flow meter shall indicate totaliser / integrator to get the daily and monthly discharge as stated above.

2.16.06 **REVERSE ROTATION INDICATOR (RRI)**

For each of CW pumps & ACW pumps, a reverse rotation indicator comprising of proximity sensors, processing electronics with output of 4-20mA (corresponding to speed) interconnecting cables, speed display in rpm, normal, reverse indication and required channel alarm contact shall be provided. The contact rating shall be 60 VDC, 6VA (or more if required by Control system). The exact details of the RRI shall be strictly as approved by Owner during detailed engineering. The power supply of RRI is to be arranged by the Bidder from UPS.

2.16.07 **Non - Nucleonic (Vibration) Type Density Meter (For DM & AHP Plant):-**

Application : Liquid Density measurement

Detector

1.	Orientation	:	As per requirement.
2.	Case Material	:	SS 316L/ Cast Aluminum alloy
3.	Wetted part material	:	SS 316L
4.	Operating Principle	:	Vibration Density measurement

Convertor

1.	Output	:	4-20 mA DC isolated.
2.	Electrical Connection	:	1/2" NPT
3.	Enclosure Class	:	IP 65
4.	Local Display	:	Digital 5 digit, density display with temp. compensation.
5.	Accuracy	:	+/- 1%
6.	Response time	:	< 1 minute.
7.	Power Supply	:	230 V AC, +/- 10%, 50 Hz. From



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



UPS

2.16.08 FLOAT & BOARD TYPE LEVEL GAUGE

Type of Instrument	:	Mechanical Type (Float Operated)
Service/ Application	:	As per service requirement
Measuring Range	:	As per requirement
Material Specification		
a) Float Material	:	SS316 having 2 nos. Guide wires
b) Float Wire Pulley	:	Shall comprise of 2 nos. Cast Aluminum Pulley housing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be SS316L. Between 2 pulleys, 1" NB G.I. short pipe.
c) Guide wire Assembly	:	CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L.
d) Counter Weight	:	MS counter – weight with Aluminum Pointer and Brass assembly Pull Chain.
e) Scale details	:	Aluminum/SS316 scale Graduated in mm with 1% accuracy of full scale range with arrow.
Nozzle Details	:	For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type).
Process Connection	:	Flanged as per ANSI B 16.5 to suit 1" NB nozzle
(Nozzle length - 150 mm for float wire, 100 mm for guide wire)		
Accessories (to be supplied with the instrument)		
a) Counter flange	:	All mating Flanges, Nozzle
b) Mounting Accessories	:	All mounting accessories
c) Tag Plate	:	To be provided (material SS316)



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Location : Field (Direct Mounting)

2.17.00 AC PLANT AND COMPRESSOR RELATED SPECIAL INSTRUMENTS

2.17.01 (HUMIDITY SENSOR)

Sensor : Capacitance type
Accuracy : +/-3% R.H
Range : 0-100% R.H
Output : 4-20 ma
Time constant: 2 mins.

Output from the sensor is to be connected to respective control system. Bidder can also provide combined instrument for measurement of humidity and temperature subject to Owner's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

2.17.02 TEMPERATURE/ HUMIDITY INDICATOR

Sensor : RTD for (Pt 100) for temperature
: Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display : Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range : 0-60 Deg C for temperature.
: 0-95.0 % for Relative Humidity.
Accuracy : Better than +/-0.5 % for Temperature
: Better than +/-2.5 % for Relative Humidity
Mounting : Table Top/ wall mounting
Power supply : 240 V AC, 50 Hz.
Output : 4-20 mA signal each for temperature.
Qty. : 15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

2.17.03 DEW POINT METER

Type : 2 Wire Loop Powered Dew point
Transmitter



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	a) AUTOMATIC CALIBRATION (b) Can be Configured for Linear 4-20mA signal in °C & °F Dewpoint, ppm(v), ppb(v), g/m3 (c) Temperature Compensation (d) Failure Diagnostics (e) Long Term Stability (f) Fast Response (g) IP 66 / NEMA4X Protection (h) Supplied with Calibration Certificate Traceable to National & International Humidity Standards (i) Sensor protection with sintered filter (j) Local LCD Display for Dew Point

2.18.00 Limit switches

For offsite plant application Limit switches shall be gold plated with high conductivity and non corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 65. Contact shall be either 1 no, DPDT or 2 nos. SPDT minimum.

For main plant application, limit switches are to be provided as per bidder standard and proven practice.

All limit switch shall be conform to IEC-60947-5-1.

2.19.00 MATERIAL HANDLING SYSTEM RELATED SPECIAL INSTRUMENTS

2.19.01 PULL CORD SWITCH

Type	:	Addressable Type
Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp, Breaking 2 Amp. (240 V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Manual Reset
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	Flame proof/Explosion proof for NEC class 2, Division 1 area
Local trip indication	:	Required
Accessories	:	1. Canopy over lever of pull Cord switch. 2. Linking of switches through a single cable for each section.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.

9.07.02 Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.

9.07.05 The Bidder shall be responsible for proper grounding of all equipment under this package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests.

9.07.06 The Bidder shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Bidder.

9.08.00 Field Mounted Local Junction Boxes

Type of Enclosure	:	Flame proof/weather proof IP-65 /Explosion Proof as per area classification. Design as per NEC-370 Article 18, 19 & 20.
No. of Ways	:	12/24/36/48/64/72/96/128 with 20% spares terminals.
Material	:	4 mm min. thick FRP (Fiberglass Reinforced Polyester) with protective Coating
		3 mm min. thickness Die cast aluminum for Flame proof/Explosion proof area.
Cable entry	:	Bottom or Side
Cable glands	:	Double compression type – Nickel plated Brass/SS316 with PVC hoods.
Mounting	:	Indoor/Outdoor
No. of terminals	:	As required with standardization with 20% spare of each size & type.
Terminals	:	Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable for conductor size up to 2.5 sq. mm)
Grounding	:	Two terminals for body and shield ground
Door	:	Hinged, lockable type.
Accessories	:	Suitable mounting clamps and other accessories shall be in scope of bidder.
		The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of SS304, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.

M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)

Gasket (Normal)- Neoprene/Polyurethane thickness 6.0 mm. Silicon for high Temp. area.

Colour : To be decided during detailed engineering & subject to owner's approval.

9.09.00 **Conduits**

Conduits shall be generally used for interconnecting cables from field instruments to local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS:9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated galvanised steel with, water leak, fire and rust proof protected for the areas of Mills, Drum, Main steam, RH steam Air Heaters and Furnace, BFPDT's.

And for remaining application, water leak, fire and rust proof flexible GI conduits shall be provided. The temperature rating of flexible conduit shall be suitable for actual application.

The Bidder shall install conduits according to the general routing as approved by owner and shall coordinate conduit locations with other works.

All grounding bushings within all enclosures shall be wired together and connected internally to the enclosure grounding lug or grounding bus with 8 AWG bare copper conductors. Conduit runs to individually mounted equipment shall be grounded to the Owner's cable tray grounding conductor with 12 AWG bare copper conductor. All grounding bushing, clamps, and connectors shall be subject to approval of the owner.

All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanised steel fittings shall be used with steel conduits. All flexible conduit fittings shall be liquid tight, galvanised steel. The end fittings shall be compatible with flexible conduit supplied.

All individually mounted equipment and devices shall be connected to the supply conduit, using not more than one meter of flexible conduit adjacent to the equipment or device. Flexible conduit shall be installed in all conduit runs, which are supported by both building steel and structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by the turbine generator foundation and where conduit supported by building steel or foundation becomes supported by steam generator framing.

Special areas, such as control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main Building framing to the control room framing.



REV. NO. 00 DATE :

Hydrogen Gas System Instruments/Analysers

Hydrogen Gas Hygrometer

A	Performance	
1	Measuring Range	-80 C to 20 C
2	Response Time for 63% Step Change	<5 sec.
3	Output Resolution	0.01 mA
4	Storage Temp: Max	70°C
5	Operating Ambient Relative Humidity	<95%
6	Sensitivity	< 5 se conds for 63% s tep ch ange i n moisture content
B	Construction	
7	Measuring Principal	Thin Film Alum Oxide
8	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
9	Display	3-1/2" Digit LCD
10	Mounting	In Explosion Proof Box
11	Location (Hazardous)	Hydrogen delivery after compressors.
12	Service	Measures Moisture co ntent i n t he Hydrogen Delivery
13	Code & Standard	EMC di rective 89/ 336/EEC and P ED 97/23/EC f or DN<25 - FM Standard 6320
14	Analog Output	4-20 mA, HART.
15	Type of Transmitter	4 to 20 mA loop powered 24 VDC
16	Certification	CE
17	Calibration	Required ev ery 12 m onths, C alibrator shall be supplied by bidder.

TRACE OXYGEN (O2) in Hydrogen gas Analyser

A	Performance	
1	Nature of Fluid	Oxygen in Hydrogen
2	Response Time for 90% step change	< 10 sec.
3	Relative Humidity	0-99 %
4	Measuring Range	0-100 ppm
5	Accuracy	+ 2%
6	Repeatability	+ 0.1 ppm
7	Sensitivity	0 - 10 ppm < 45 seconds
B.	Construction	
8	Measuring Principle	Electrochemical Fuel Cell
9	Display	3-1/2" Digit LCD
10	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
11	Mounting	On Panel with Sample System
12	Service	Measure t race oxy gen i n t he pr oduct hydrogen
13	Location (Hazardous)	Hydrogen delivery after compressors.
14	Code & Standard	ATEX Approved. II 1/2 G Ex ia II c T4
15	Output Current	4-20 mA, HART
16	Type of Transmitter	4 to 20 mA Loop powered 24 VDC
17	Calibration	Every 12 months with c alibration g as,



REV. NO. 00 DATE :

18	Calibration Gas	Calibrator shall be supplied by bidder. 5ppm O2 in N2, shall be provided by bidder for one year after commissioning of plant.	
Combined Gas Sensor for Hydrogen Gas System			
A	Performance		
1	Nature of Fluid	Hydrogen /Air	
2	Measuring Range	0 to 100% LEL	
3	Response 50%	<10 sec.	
4	Recovery to 10%	<30 sec.	
5	Accuracy	0-50%LEL range	51-100% LEL range
		+ 1%	+ 2%
6	Repeatability	+ 1%	
7	Calibration frequency	180 days	
8	Output Range: 0-100 LEL	4-20 mA, HART	
9	Humidity RH	<99%	
10	Sensitivity	<12 seconds to 60% full scale	
11	Measuring Range	0-100 ppm	
B.	Construction		
12	Measuring Principle	Catalytically bead	
13	Enclosure Protection class	intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.	
14	Display	3-1/2" Digit LCD	
15	Mounting	4 mtrs above respective instruments supporting Conduit	
16	Service	Monitor combustible mixture in the atmosphere of each room where hydrogen may be present.	
17	Location (Hazardous) (one in each), Any other location as finalised by owner during detailed engineering.	Roof -H2 Generation room Roof - Compressor Room Roof - H2 Storage Room	
18	Code & Standard	FM Standard 6320 FM Standard 3600	
19	Type of Transmitter	4 to 20 mA Loop powered 24 VDC	
20	Calibration Gas	2% H2 in N2, shall be provided by bidder for one year after commissioning of plant.	
21	Calibration	Every 6 months with calibration gas , Calibrator shall be supplied by bidder.	
Hydrogen Gas purity measurement Analyser			
A	Performance		
1	Range	80% to 100 % H ₂ in air 0 to 100 % H ₂ in pure gas * 0 to 100 % air in pure gas *	
2	Accuracy/Linearity	+ 1 % of FSD	
3	Resolution/Repeatability	+ 0.5 %	
4	Response Time for 90% step change	< 5 sec.	



REV. NO. 00 DATE :

5	Stability/Drift	< $\pm 1\%$ of FSD/month
B.	Construction	
6	Measuring Principle	Thermal Conductivity or Multi mode Oscillation type
7	Enclosure Protection class	Intrinsically safe and explosion proof as per N E C article 500, class 1, Division 1 area I.
8	Display	3-1/2" Digit LCD
9	Safety & EMC Standards	Safety Standards EN 61010-1 EMC Standard EN 61326
10	Output	2 nos. 4 – 20 mA DC, isolated from input
11	H ₂ Purity	99.99%
12	Calibration Gas	shall be provided by bidder for one year after commissioning of plant.
13	Calibration	Every 6 months with calibration gas, Calibrator shall be supplied by bidder.
14	Note: * Pure Gas options: CO ₂ , N ₂ , Argon	

CHAPTER-14 : PLANT AUXILIARY SYSTEMS**14.00.00 CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS**

- 14.00.01 Bidder shall provide complete Control and Instrumentation system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of the plant auxiliary systems as indicated under scope part at Part-A & Part B, Vol. V.
- 14.00.02 Bidder shall provide control system for safe, efficient and reliable operation of each of the plant auxiliary systems. The type of control system shall be as indicated under scope part at Part-A, Vol. V.
The quantity of instrument for each plant auxiliary system shall be as per tender P&ID wherever provided of the respective system as a minimum for bidding purpose. However Bidder shall also included in his proposal all instruments and devices which are needed for the completeness of the plant auxiliary system/equipment supplied by the contractor if the same is not specifically appearing in the P&ID.
- 14.00.03 The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardized. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit etc.
- 14.00.04 The Control system shall include on-line self-surveillance, monitoring and diagnostic facility giving the details of the fault on the Human Machine Interface System (HMIS) as per standard and proven practice of the bidder.

For Fire Protection systems, the faults to be reported shall include fault in main & standby power supplies, sensor fault, Input/ Output card failure, Memory Status, Controller fault, failure of Communication/ Network links to PLCs, LAN etc. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place.
- 14.00.05 The Control system shall generally operate in air conditioned area and shall be suitable for sustained operation for limited air conditioning failure.
- 14.00.06 PLC systems related to Fire Protection systems shall be interconnected with Fire Alarm panels also and redundant interface to DDCMIS from Fire Alarm panels is also envisaged. The alarm signals from PLC system & fire alarm system shall be provided to DDCMIS by interconnection of FAP at CER with DDCMIS. Hardwired signals shall be provided for interlock, protection & alarm from Fire alarm panels to main plant DDCMIS and respective off-site DDCMIS/PLC.
All electronic devices like Switches/Transmitters/Controller/Analyser/Solenoid valves which are located in Hydrogen Generation Plant shall be made intrinsically safe by providing suitable type of Transformer isolated barrier/Zeener barrier of standard make. Otherwise such instruments shall be provided with explosion proof enclosure suitable for hazardous area described in National Electric Code (USA), Article 500, Class-I, Division-I or EN 60079-14 or shall comply with essential requirements of ATEX directives. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.

14.01.00 MICROPROCESSOR/ PROGRAMMABLE LOGIC BASED CONTROL SYSTEM

14.01.01 Microprocessor/PLC PROCESSOR

The processor unit shall be capable of executing the following functions:-	
a	Receiving binary and analog signals from the field and providing command output to MCC/SWGR/Drive etc. through Input / Output modules and operator initiated commands from HMIS / control panel.
b	Implementing all logic functions for control, protection and annunciation of the equipment and systems.
c	Implementing modulating control function for certain application as specified elsewhere in the specification.
d	Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
e	Performing self-monitoring and diagnostic functions.

14.01.02 PLC system shall consist of two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete process operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor.

Wherever multiple functional groups have been specified/ required, the above requirements are applicable for each functional group.

The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient (min. 4 MB per CPU) for system operation and shall have the capability for future expansion at least to the tune of 40%.

Programmed operating sequences and criteria shall be stored in non volatile semi conductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup which shall be for at least 360 hours. The batteries shall be lithium or Ni-Cd type.

14.01.03 Priority of different commands shall be as follows:

Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

14.01.04 The latest proven PLC system shall be provided. Bidder to note that PLC system shall be from one manufacturer only. PLC system supplied & engineered through system house shall not be acceptable. It should be supplied & engineered from PLC manufacturer only. PLC should be sourced from original manufacturers. PLC system shall be complete with hot standby redundant CPU of word length of 32 bits minimum with floating point capability, Input / Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be hot redundant for each CPU & I/O rack. PLC system will be interfaced with main and respective DDCMIS through dual redundant interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.

14.01.05 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard.

Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks being performed to the other healthy CPU within fastest possible transfer time (i.e. ≤ 50 m sec.) without causing any output to drop during the Transfer period. In the Event of the both the CPU failure, the system shall revert to the Fail-safe mode. The CPUs shall not be loaded over 60% of the Individual capacity even under worst data loading conditions. It shall be possible to switch from the active to the back-up CPU and vice versa from Operating station as well from the CPU front panel. (The worst data condition of PLC means all modules in active mode, printer in operation, OLCS & CLCS logics active and process in running condition). Data bus loading shall not be more than 50%. This configuration shall be applicable for each type of PLC based control system. Engineered solutions for redundancy in CPU & I/O cards are not acceptable.

The quantities of Hot standby redundant CPU/controllers for each PLC system shall be finalized during detailed engineering by owner depending upon CPU/controller's worst data loading conditions and CPU/controller's functional distribution.

14.01.06 System Expandability

Modular System design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, I/O cards, hand/auto stations, push button stations, peripherals like Large Video Screen (LVS), operator workstations (OWS), printers etc. while the existing system is fully operational. The system shall have the capability to add any new control loops, groups/subgroups, in control system while the existing system is fully operational.

14.01.07 On Line Maintenance

It shall be possible to remove/replace various modules online (like I/O module, interface module etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected. Further, it shall also be possible to remove/replace any

of the redundant controller module without switching off the power to the corresponding rack and this will not result in system disturbance or loss of any controller functions for the other controller. The on-line removal/insertion of controller, I/O modules etc. shall in no way jeopardise safety of plant and personnel.

14.01.08 **Fault Diagnostics**

The PLC shall include on-line self-surveillance, monitoring and diagnostic facility so that a failure/malfunction can be diagnosed automatically and reported/indicated remotely on OWS/Engineering cum Programmer station. The failure/ malfunctions/faults to be reported shall include:

- (a) Module level faults of control system.
- (b) Failure of HMIPIIS bus/unit LAN, system bus, Local/Remote communication Bus.
- (c) Power supply faults (Over voltage, under voltage, loss of input) for each feeder of power supply for system / marshalling/ relay and HMIPIIS cabinets.
- (d) Software faults.

These faults shall typically be reported as colour change on system status display and messages on programmer station/OWS as well as through local indication. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place. Failure of any I/O modules, Controller etc. shall be annunciated to OWS. For I/O modules, these alarms shall be grouped, while for controller, comm. controller, power supply, these shall be individual. In case the faults are not acknowledged / rectified within certain interval, then the same shall be reported to predefined users through messaging system described subsequently in this subsection. The exact strategy of the messaging system shall be elaborated and finalised during detailed engineering.

HMIPIIS shall include on-line self surveillance, monitoring and diagnostic facility so that a failure/malfunction in any of the nodes, networking device as well as communication medium can be diagnosed on the programmer/engg. Work station/OWS.

14.01.09 **Fault Tolerance & Controllability**

- 14.01.09.01 The PLC shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardised. Control System shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuits/short circuits, instrument air supply failure etc. On any of these failures the control system output shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalised during detailed engineering. System shall be designed such that there will be no upset when Power is restored.

- 14.01.09.02 I/O modules shall have protection so that any fault in sensor & its wiring upto I/O module like open/short circuit, earth fault affects only that channel of I/O module. Other channels of that I/O module or other modules or other parts of system shall not be affected in any way.
- 14.01.09.03 No single failure either of equipment or power source shall be capable of rendering any part/system/sub-system of PLC inoperative to any degree. No single failure in HMI/PLC shall lead to non-availability of more than one OWS or one LVS. In such an event i.e., single failure leading to non-availability of any OWS/LVS, it shall be possible to operate the entire plant in all regimes of operation including emergency conditions from each of the other available OWS/LVS.
- 14.01.09.04 In order to achieve above, following shall be redundant with automatic change-over (including the associated software), as a minimum:
- Controller, Comm. Controllers, HMI/PLC bus/Unit LAN, System bus, Local/Remote communication bus.
- Power supply arrangement (feeders/modules)
- Output modules.
- Servers/information work stations
- However, following need not be redundant:
- I/O bus, (if it is a backplane bus & extension/joining of such backplane buses cabinet / adjacent cabinet) and input modules.
- 14.01.09.05 The system design shall ensure that no single failure, whatsoever in any part of PLC result in loss of communication except communication between HMI and control system, for which loss of communication upto a maximum of five seconds is acceptable. However, during this period, the control system shall remain fully functional and this event shall not create any disturbance/malfunction whatsoever (e.g., accumulation of control commands, issue of spurious commands/signals etc.).
- 14.01.09.06 On power supply failure/PLC failure/communication failure etc. the output should be automatically switched over to the fail safe mode. In CPU, memory should exist where the sequence was aborted. Further in case of such failures, operating drives/ equipment shall be tripped or kept running as per a pre-determined programmable finalized during detailed engineering.
- 14.01.09.07 PLC shall meet all requirements stipulated under other Sub-sections/sections of the specification including Part A, Chapter 8, Vol II, (including the requirement Authorisation to shipment test ATST) Quality assurance (Vol, II, Chapter 11) & General Technical Requirements (Vol, II, Chapter-5).

14.02.00 HUMAN MACHINE INTERFACE SYSTEM (HMIS)

- 14.02.01 Graphical Interface Unit (GIU) / Operator work station (OWS) shall perform control, monitoring and operation of all auxiliaries/ drives

interacting with PLC based/Microprocessor control system. It shall be possible to use the same as programming station of the PLC/ Control system and the Human Machine Interface System. In case the PC based OWS can not be used as programming station of the PLC/ Control system and the Human Machine Interface System, then separate PC based programming station shall be provided (Refer Annexure A for details).

- 14.02.02 Operator shall be able to access all control/information related data under all operating conditions including a single processor/computer failure in the HMIS.
- 14.02.03 The operator functions for each OWS shall as a minimum include Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering.
- 14.02.04 The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. The display response shall be 1 sec maximum for control related displays. 2 to 3 sec for other displays.
- 14.02.05 The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorised use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights as finalised by the Owner during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).
- 14.02.06 When any drive or sequence is being controlled from one OWS, the system shall inhibit control access of the same drive or sequence from other OWS or Local Control Panel.
- 14.02.07 Graphical Interface Unit shall meet the minimum functional requirements of monitoring, operating & controlling the process and displaying information related to process. GIU shall be provided with TFT active matrix display and keypad for operation. GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.

14.03.00 PROGRAMMING FUNCTIONALITIES

Programming of the PLC/ Control system Processor / controller as well as programming of HMIS shall be user friendly with graphical user interface and shall not require knowledge of any specialized language. For example, the programming of PLC/ Control system shall use either of the

-	Flow-chart or block logic representing the instructions graphically.
-	Ladder diagrams.
The programming of HMIS (like development and modification of data base, mimics, logs / reports, HSR functionalities etc.) shall also be possible through user-friendly menus etc	
All programming functionalities shall be password protected to avoid unauthorized modification.	

14.04.00 SOFTWARE REQUIREMENT

- 14.04.01 All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The bidder shall provide sufficient documentation and program listing so that it is possible for the Owner to carry out modification at a later date.
- 14.04.02 The Bidder shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.
- 14.04.03 Industry standard operating system like UNIX/WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry standard protocols (TCP-IP/ OPC etc.) shall be provided. The system shall have user friendly programming language & graphic user interface.
- 14.04.04 All system related software including Real Time Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.
- 14.04.05 All application software for PLC/ Control system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.
- 14.04.06 The Bidder shall provide software locks and passwords to Owner's engineers at site for all operating & application software so that Owner's engineers can take backup of these software and are able to do modifications at site.

14.05.00 INPUT/OUTPUT MODULES

- 14.05.01 The PLC/ Control system should be designed according to the location of the input/output cabinets as specified.

The max number of Input / Output points per card shall be 32 for digital and 16/8 for Analog / Thermocouple / RTD. No. of channels may also reduced to meet the I/O cards features specified in NIT. Individual input channels shall have galvanic isolation. Output points shall also have optical / galvanic isolation. Merely fusing

of individual or a group of channels is not acceptable. The I/O cards shall be rack mounted. Failure of Analogue I/O cards, binary cards / modules shall also be displayed on the Engineering cum diagnostic station. Redundancy of I/O cards shall be as per design criteria & guidelines as specified elsewhere in the specification.

- 14.05.02 Input Output modules, as required in the Control System for all type of field input signals (4-20 mA, RTD, Thermocouple, non change over/change over type of contact inputs etc.) and outputs from the control system (non change-over/change- over type of contact, 24 VDC output signals for energising interface relays, 4-20 mA output etc.) are to be provided by the Bidder as described in Vol. V, Part A.
- 14.05.03 Electrical isolation of 1.5KV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall ensure that any inadvertent voltage or voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment. All I/O cards shall be provided with channel to channel isolation and self diagnostic features.
- 14.05.04 The Input/output system shall facilitate modular expansion in fixed stages.
- 14.05.05 Individually fused output circuits with the blower fuse indicator shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses preferably for each input; alternatively suitable combination of inputs shall be done and provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems. For Hydrogen Generation plant, Bidder's standard and proven practice in this regard shall also be taken into consideration.
- 14.05.06 All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.
- 14.05.07 The Bidder shall provide the following monitoring features:
- a. Power Supply monitoring
 - b. Contact bounce filtering
 - c. In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Bidder during detailed engineering.
- 14.05.08 Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA at 24 VDC. and solenoid valves at 24V DC or 110/230 V AC. The coupling relays shall be provided in LT/HT switchgears. Analog output modules shall be able to drive a load impedance of 500 Ohms minimum.
- 14.05.09 Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays etc. without any extra hardware.
- 14.05.10 Changeover contact or non changeover contact shall be provided in MCC for status feedback, control and interlock requirement as described in Vol. V, Part A,

Table Drive I/O. Further multiplication, if required, shall be done by the bidder in PLC/ Control system.

- 14.05.11 All input field interrogation voltage shall be 24V DC.
- 14.05.12 In case of loss of I/O communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be decided during detailed engineering) with proper annunciation.
- 14.05.13 Any single sensor/transducer/transmitter failure alarm shall be provided on programmer/Engineering station screens for all sensors/transducers/transmitters. Bidder shall provide remote Input/output modules Housed in free-standing cabinets/racks (with suitable redundant data link to the central PLC system) as specified. These Input/output modules shall meet the technical requirements as mentioned in the above clauses. Further these Input/output modules shall be designed to continuously work under the environment expected to be encountered in assigned areas without any air-conditioning support. Wherever the cable route distance of these I/O cabinets/racks exceeds a distance of 400 meters from the Central PLC, fiber optic data link has to be provided.

14.06.00 SYSTEM SPARES CAPACITY

- 14.06.01 Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, Control System shall have spare capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site:
- 14.06.02 10% spare channels in each input/output modules fully wired up to cabinets TB.
- 14.06.03 Wired-in "usable" space for 10% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in system cabinets.
- 14.06.04 Each processor / controller shall have 30% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops.
- 14.06.05 The Data communication system shall have the capacity to handle the additions mentioned above.
- 14.06.06 Twenty (20) percent spare relays of each type and rating mounted and wired in cabinets TB. All contacts of relays shall be terminated in terminal blocks of cabinets.
- 16.06.07 20% spare fully wired terminals of each type shall be provided in each cabinet.

14.07.00 DATA COMMUNICATION SYSTEM (DCS)

- 14.07.01 The Data Communication System shall include a redundant Main System Bus with hot back-up. Other applicable bus systems like cubicle bus, local bus, I/O bus etc shall be redundant except for backplane buses which can be non-redundant.

The DCS shall have the following minimum features :	
a	Redundant Communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLC/ Control systems and between PLC/ Control systems and operator work station/HMI device.
b	The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.
c	Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged.
e	The design and installation of the system bus shall take care of the environmental conditions as applicable.
f	Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc.
g	Passive coaxial cables or fibre optic cables shall be employed.
h	Communication links between CPU and individual Input & Output (I/O) modules rack shall be dual redundant with 10 Mbps speed and 16 bit CRC data protection feature. In no case failure of a link shall affect the control of the plant.
i	Each Network shall also be provided with external surge protection system and industrial firewall.
The Bidder shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.	

14.07.02

The PLC/ Control system shall be provided with necessary hardware and software for dual fiber optic connectivity & interconnection with station wide LAN (for scope of Station LAN refer vol-V, Part-A) for transfer of signals for the purpose of information sharing. The plant information shall be made available through an Ethernet link following TCP/IP standard. The system shall be OPC compliant. The exact data structure shall be as decided during detailed engg. All required plant data shall be transferred to/from through this ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalised during detailed engineering. One additional Ethernet port shall be made available in PLC system for connectivity of wireless communication modem for future use. The Bidder shall provide all assistance to the BOP C&I System (for scope of BOP

C&I System refer Vol.-V, Part-A) Supplier including co-ordination and flow of required information etc. for display of all input points under alarm, connected to PLC/ Control system or generated by PLC/ Control system, on various operating stations on BOP C&I System (for scope of BOP C&I System refer Vol. V, Part-A) and various client PCs on station LAN.

14.08.00 SYSTEM REACTION TIME

14.08.01 The reaction time of the programmable control system from input signals at the input cards to output of the associated signals or commands of the output card inclusive of programmed logic processing, comprising a mixture of logic gates, arithmetic operations and other internal operations shall be less than 100 milli seconds under the most arduous control system operating conditions.

14.09.00 OPERATOR INTERFACE DISPLAYS/LOGS/REPORTS

14.09.01 Suitable Operator Interface Displays/Logs/Reports for control operation & monitoring shall be provided. The details shall be finalized during detailed Engg. stage taking into account the bidders standard and proven practice.

14.10.00 HISTORICAL STORAGE AND RETRIEVAL SYSTEM (HSRS)

14.10.01 The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalised during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least last seven (7) days shall be available on the disk. Memory capacity of hard disk shall be finalized accordingly.

14.10.02 In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long term storage media). These data will include any data from the database as well as processed/computed data based on various calculations/transformation. The retrieved data from long term storage media should be possible to be presented in form of X-T display, X-Y display, logs, reports, etc.

14.11.00 CONTROL & POWER SUPPLY SCHEME

14.11.01 General Requirements

The requirements of Electrical Power Supply system are specified herein on system basis. The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification including tender drawings. All equipment and accessories required for completeness of this system shall be furnished by the Bidder whether these are specifically mentioned herein or not. All the equipments and sub systems offered shall be from reputed experienced manufacturers. All system cabinets, enclosures, & distribution boards shall be manufactured, assembled,

wired and fully tested as a complete assembly as per the requirements of this specification at the manufacturer's works.

(A) 24V DC power supply system for PLC based control system for all Offsite packages except for CHP's off site package shall comprise of two sets, each set shall consist of 1 x 100% Chargers, 1 x 100% Nickel - Cadmium batteries for one (1) hour duty, 1 X 100% DC distribution board. For specification of power supply system refer Sub Section, Vol.-V, Part B, chapter 7, Cl. No. 7.01.03 (A) of Specification.

(B) For CHP's off site packages, Parallel redundant 230 V AC to 24 V DC convertor with automatic 50% load sharing & 125 % capacity shall be provided for 24 V DC power supply in each cubicle separately as per requirements.

The UPS power supply shall be extended to Parallel redundant 230 V AC to 24 V DC convertor thru redundant UPS feeders.

AC to DC convertor shall be SMPS based and shall have wide range of AC/DC input voltage (85-264 V AC & 90-350 VDC). It shall have the necessary diagnostic functions like indications for DC OK, automatic overload monitoring etc. The MTBF for the power supplies shall not be less than 500,000 hours (in Accordance with (IEC - 1709) with operating temp. from -25deg. C to 70 deg. C.

There should not be Diode oring for switch over. There should be separate power supply (230 V AC to 24 V DC convertor) with parallel redundant features with automatic 50% load sharing and indication & alarm on 230 V AC to 24 V DC convertor failure.

Pot free contacts shall be provided for 230 V AC/24 V DC convertor Fail alarm, 24 V DC under voltage alarm, 24 V DC over voltage alarm etc.

(C) For CHP's off site packages and PLC based off site packages, UPS System shall consist of 2 x 100% parallel redundant chargers and inverters with input isolation transformers, 1 x 100%Ni Cd battery bank for one (1) hour, Bypass line transformers & voltage stabilizer, static switch manual bypass switch, 2 x 100% ACDB, and other necessary protective devices and accessories. The UPS shall consist of complete hardware and software for remote management.

The specifications for this configuration shall be as per Cl. No. 7.06.00 to 7.10.00 as a minimum.

(D) All interconnection hardware including cables to be provided.

14.12.00 CONTROL CABINETS / PANELS/Desk

14.12.01 The cabinets shall be IP-32 protection class with a suitable canopy at the top to prevent ingress of dripping water. The Bidder shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. This shall be demonstrated to the Owner during the factory testing of the system. The Bidder shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the

safe limits for system components even under the worst condition as specified in Sub-section-basic Design criteria (Part-B, Vol. V) and specification requirements for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.

- 14.12.02 The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables.
- 14.12.03 The cabinets shall be totally enclosed, free standing type and shall be constructed with design criteria specified in Vol. V, Part B, Chapter 6, preferred height of the cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Owner and shall be furnished by the Bidder during detailed engineering.
- 14.12.04 Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.
- 14.12.05 Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. The detailed of panels/control desk and finish colours for exterior and interior surfaces shall be as per Vol.V, Part B, Chapter 6.
- 14.12.06 Paint films which show sags, checks or other imperfections shall not be acceptable.
- 14.12.07 As an alternative, single coat of anodic dip coat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.
- 14.12.08 Refer Vol. V, Part B, and Chapter-1 for grounding requirements & panel protection class.
- 14.12.09 The mimic shall be configured on the OWS and it shall be possible to control, monitor and operate the plant from the same.
- 14.12.10 The technical specification covering panel fabrication details, wiring and termination details etc. shall be as described under Chapter 9, Vol. V, INST CABLE of this specification.

14.13.00 ANNUNCIATION SYSTEM



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



- 14.13.01 OWS based alarm system shall be provided with audio alarm facility (beep/tone generator). Hooters are to be provided.
- 14.13.02 The system shall display history of alarms in chronological order on any of the OWS. The system shall have all alarm functions and related function keys like alarm acknowledge, reset, paging, summaries etc. The alarm display/report format shall be as approved by the Owner.
- 14.13.02 Facility of audio annunciation shall be provided in OWS upon the occurrence OWS alarms irrespective of whether alarms are displayed or not. Facility to disable the audio annunciation shall be provided.
- 14.13.03 At least four levels of alarm priority shall be available which will be displayed in different Colour. It shall be possible to display & print alarms of any of the three levels.
- 14.13.04 Alarm boxes shall be provided in each display to alert the operator about an alarm when he is viewing some other picture. No of alarm boxes shall be finalised during detailed engineering for each process area & each priority therein.
- 14.13.14 Hardwired Annunciation system shall be provided for offsite packages as listed in Annexure A, Chapter 14, Part B, Vol. V.

14.14.00 **CONTROL DESK**

- 14.14.01 For off site packages, Control desk shall be provided to keep the LED monitors at top and computers inside. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. PA system handsets, telephone sets, any PB stations and lamps required shall be mounted on the control desk on mosaic grid structure and same shall be decided during detailed engineering. ASCII Keyboard shall be capable of being pulled out through a tray. NIT's GA drawings for control desk & printer tables shall be complied by bidder.
- 14.14.02 The cabling / wiring between OWS & CPU'S, power supply cables etc. shall be aesthetically routed and concealed from view.

14.15.00 **FURNITURE**

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. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finalized & approved by Owner during detailed engineering.

14.16.00 SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS



14.16.01 All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the PLC/Control system shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalization for Owner's review and approval.

14.16.02 All The software listings including source code for application software, All special - to-project data files etc. shall be submitted by the Bidder.

14.17.02 SOFTWARE LICENCES

The Bidder shall provide software license for all software being used in Bidder's System. The software licenses shall be provided for the project (e.g. organisation or site license) and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Owner to seek a new license/renew license due to upgradation/change of hardware/machine in Bidder's System at site. All licenses shall be valid for the continuous service life of the plant.

As a customer support, the Bidder shall periodically inform the designated officer of the Owner about the software upgrades/new releases that would be taking place after the system is commissioned so that if required, same can be procured & implemented at site.

14.18.00 (A) SPECIFICATIONS OF OWS

The minimum requirement for OWS shall be as per Vol. V, Part B, Chapter 3.

UPS : 1 no. on-line Interactive UPS with 30 mins. battery backup on machine load (for OWS & its printer) with all accessories and software for remote monitoring facility for main off site package except CHP's off site package.

Accessories : Required furniture for mounting of HMI peripherals shall be provided.

(B) GRAPHICAL INTERFACE UNIT

The minimum requirement of Graphical Interface Unit are as follows:

SI No.	Features	Description
1.	Power supply (Redundant)	24 V DC or 230 V AC from UPS as per requirements.

2.	Display Type	10.4" – 15" sized minimum Colour, high resolution TFT screens with keypad. Actual size as per owner approval.
3.	Humidity & Operating Temperature	5-95%, 0-50 deg C
4.	Protection class	IP-65 for extremely dust prone area, otherwise IP-55. Enclosure shall be provided to prevent ingress of dust.
5.	Keys	Function keys and numeric keys
6.	Interfacing requirements	Interface with respective PLC system
7.	Functional requirements	Ability to operate drives locally using function keys Graphics display including alarms and operator guidance messages.
8.	Enclosures	Required as per site/process requirements.
9.	Other requirements	Industrial Grade, GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.

Note: Refer Appendix to Part-A and Annexure A to chapter 14, Vol. V FOR QTY of GIU.

14.19.00 PRINTER

14.19.01 Printers for Off-site packages shall be provided as indicated in Chapter 14, Annexure A as a part of the HMIS system. It shall print out all alarm/trip conditions and event changes in plant status along with date and time of occurrence.
The minimum requirement for printers & accessories shall be as per Vol. V, Part B, Chapter 3.

14.20.00 PLC Configuration:

The PLC configuration will have a hierarchy of industrial grade open system architecture for management information system (MIS) and closed system architecture for plant operation and control system.

The complete MIS system including hardware, software, cables etc, as required shall be provided. This shall acquire dynamic pre-configured points and mimics as required by Owner.

The closed system architecture for plant operation and control system is secure and deterministic system for real time operations of the plant.

Industrial grade managed type Ethernet switches shall be provided with features as same as specified at Vol V, Part B, Chapter 3.

PLC Network shall also be provided with external surge protection system and firewall.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of device shall at least be 10 KA, 8/20 μ Sec between core-core and 20 KA, 8/20 μ Sec between core-ground. The device shall be pluggable & on-site testable".

All the operator stations will be 'work stations' as same as specified at cl. no. 4.03.03.04 and are required to reside on the main redundant bus running on IEEE 802.3, IEEE 802.4 or IEEE 802.5 to facilitate determinism.

PLC system shall have suitable software and hardware interface arrangement (thru MIS SERVER) so that pre-selected plant parameters and process mimics can be viewed at UPRVUNL's Head quarter on real time data basis.

PLC system shall have suitable interface arrangement for remote diagnostic support. Bidder shall provide all necessary software, hardware & broad band internet connection for remote diagnostic support.

However to protect against unauthorized access to network, sufficient security arrangement in the form of firewall or any other suitable hardware / software keys etc., shall be provided by bidder. All hardware shall be of industrial grade only.

Each PLC/Microprocessor based system/electrical system shall be time synchronized with master clock system

Complete system shall be commissioned & executed by bidder.

14.21.00 Visual Annunciation System

14.21.01 Functional Requirements

The primary objective of the Visual Annunciation System shall be to draw operator's attention to abnormalities in plant status and parametric values enabling him to take corrective measures to avoid emergency/Plant trip out conditions or decrease in plant output.

Visual Annunciation System shall be on the lines of guidelines and stipulations given in:-

1. Specifications and guides for the use of general-purpose annunciators - ISA RP 19.1 - 1979.

2. Surge withstand capability tests - ANSI C 37.90a - 1974 and IEEE std. 472-1974.

The VAS system shall consist of single channel logic cards and facia windows with LEDs arranged in appropriate groups on backup control desk etc.

Logic cards shall be built around CMOS circuits or microprocessor based card. Logic cards shall be complete with contacts interrogation, contact bounce filtering with typically 15 ms duration and LED driver circuits. Drivers to LEDs shall be with current limiting feature and be provided with current regulation and short circuit protection.

Both NO/NC contacts shall be acceptable for annunciation. Change from NO to NC or vice versa shall be achieved through dip switch/jumper connections at cable level without any change in field wiring.

Logic cards shall be provided with optical isolation feature for all input signals.

In view of contact sharing between VAS and Plants monitoring system, interrogation voltage levels in the two systems shall be matched.

- 14.21.02 Sequence of annunciation for the control desk mounted facia windows shall be as below:

S.No.	Condition	Visual	Audible
1.	Normal	OFF	OFF
2.	Alarm	Flash	ON
3.	Return To Normal		
a)	Before Acknowledge	ON	ON (Different tone)
b)	After Acknowledge	OFF	OFF
4.	Alarm Acknowledge		
a)	Before Return To Normal	Steady ON	OFF
b)	After Return To Normal	Slow Flashing	ON (Different tone)
5.	Reset	OFF	OFF
6.	Test	Flash	ON

Note: Pitch and volume of the tone generators for the audible alarms shall be adjustable. The hooters, buzzers, beacon lamps etc. shall also be provided above the same section. Each audible device shall be driven by separate tone generator.

- 14.21.03 **Specific Requirements**

The facia window shall be translucent/plastic window with engraving with 16 nos. light emitting diodes with minimum average forward current - 50 mA, axial intensity 30 mcd at 25 mA and colour range 525 to 590 nanometers for red colour.

Size of Facia windows shall be 72(L) x 48 (H) mm.
The power supply to annunciator shall be monitored.

The VAS shall be designed for expansion capability upto 10% by more addition of requisite logic cards alone.

Inputs sizing group alarm facility, retransmission facia windows, power supplies and cabinets shall be designed in line.

Hooters and Buzzers provided on the panel shall be electronic with adjustable volume and pitch control. Operator interface push button stations shall be provided in appropriate sets on panels as per functional groupings desired. Push button stations shall also be provided in Operator interface.

Annunciation system shall be designed to ensure during LED / System test, existing fault annunciation is automatically excluded from test program with latching of status at card level. Once test command is removed, the system should display once again the faults annunciations.

14.21.04 Bidder shall provide Annunciation as integral part of PLC (driven with Digital Output from PLC). The number of Annunciation facia windows and Annunciation points shall be as required based. However minimum number of facia window shall be 30 Nos. for PLC operated main offsite packages. The facia window shall be mounted on desk / panel of control room.

Minimum number of facia window shall be 20 for Field mounted local control panels. However actual requirements shall be finalized during detailed engineering.

14.22.00 Redundancy Criteria (For details also refer Vol. V, Part A)

- i. Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations in critical applications.
- ii. Triple/Dual redundancy for sensors and transmitters will be used for critical and semi critical applications i.e for interlocks/trip/protection conditions (as decided by Owner).
- iii. The Wiring Scheme for inputs/outputs to/from PLC control system shall be as same specified at Vol. V, part A and Part B, Chapter 3 and as approved by owner.
- iv. All analog signals fed to the control system shall be acquired through analog card and validated.
- v. The CPU / Controllers, communication modules, data highway, power supply modules, etc for all PLCs shall be 100% hot standby redundant.
- vii. All input/output modules redundancy shall be as per Vol. V, Part A.
- viii. Drive control philosophy and Input/output sizing shall be same as specified for DDCMIS based main plant and off-site BOP packages.

14.23.00 CONTROL PANEL AND OPERATOR INTERFACE (For details also refer Vol. V, chapter no. 6)



- i. Operating console desks for OPERATING STATION's and KB shall be provided by bidder along with their printers in AC control room.
- ii. OPERATING STATION/KBD shall generally be used for control and monitoring.
- iii. Complete industrial grade Furniture for mounting Operating stations, Swivel Chairs, Printers, Keyboards, Computer etc. shall be furnished by bidder.
- iv. In the Control desk and relay based system following operator interface devices shall be provided as per Annexure A.
 - 1) Control station (illuminated P.B. stations, control switches etc).
 - 2) Hardwired Annunciator
 - 3) Coloured Mimic with LEDs for Drive status (ON, OFF, & trip) and level (Low & High) of tanks.
 - 4) Process indicators & Ammeters as decided during detailed engineering.
- v. Control panels housing the control cards/equipment marshalling cabinets shall be located in a control room; and shall have IP 32 min. . degree of protection specified at Vol V, Part B, Chapter 1 with a suitable canopy at the top to prevent ingress of dripping water , Steel sheets (CRCA) shall be adopted for fabrication, consistent with weight of devices, control equipment to be mounted. Cable gland plate thickness size shall be 3mm. Mimic shall be made of Acrylic sheet with thickness of minimum 6/7 mm.
- vi. Panels shall be furnished complete with requisite accessories such as transformers, regulators, switch-fuse units, MCB, MCCB and other power supply equipment to adopt the sources of power supply to requirements of panel mounted instruments and devices.
- vii. All panels, cabinets and enclosures shall be furnished, fully, wired with necessary provisions for convenience outlets, internal lighting, grounding, ventilation, space heating, and vibration isolation pads, double compression cable glands, integral piping and other accessories as per IS: 5039- 1969.
- viii. The sealing of panels/cabinets/enclosures bottom with bottom plate, Double compression cable glands and suitable sealing material to prevent entry of dust shall be in the Bidder's scope. Suitable arrangement for preventing fire propagation through cable entry points like fire seals etc. shall also be provided at cable entry points.
- xi. Fire/Smoke Detector, Neoprene/Polyurethane Gasket, Exhaust Fans with louvers & filters shall be provided in all consoles and panels.
- x. All the panels shall be equipped with Anti vibration pad of 15 mm size.

- xi. Bidder shall provide Ammeters on control panel/desk for all HT motor current and important LT motor ≥ 30 KW & other important drives and voltmeter for LT bus voltage.

14.24.00**RELAY BASED LOCAL CONTROL PANEL/DESK**

Local control panel shall be of 2.5 mm steel construction, free standing type, totally enclosed dust and vermin proof with enclosure protection class of IP-65 as per IS: 13947 and colour shall be as per shade no. RAL 7032/7035. One uniform colour shade as finalized during detailed engineering shall be applicable for complete plant.

Panel shall be mounted on vibration dampers secured to steel frame on to the floor. Equipment and relays mounted on the panel shall be easily accessible. The panel shall be supplied completely wired upto terminal blocks for connecting external cables entering the panel from the bottom. Blank removable gland plate shall be provided with double compression type cable glands/conduits knockout along with the panel.

Terminal block shall be rated 650 volts grade, 10 Amps rated minimum made up of unbreakable polyamide 6.6 grade and shall have strap cage clamp type screw less terminals suitable for connection with 2x2.5 sq mm copper conductors on each side. Terminal block shall be provided with white marking strips. All metal parts shall be of non-ferrous material. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250 mm. Fuses shall not be mounted on terminal blocks. At least 20 percent spare unused terminals fully wired shall be provided on terminal block.

Contactors, Relays, timers and other devices mounted on the panel shall have clearly visible identification marking. Separate contactors shall be provided for start & stop command. Common contactor for start & stop command are not acceptable. All fuses shall be HRC semiconductor type of AC supply. HRC link & fuse shall be of removable type having 45 kA rupturing capacity (min) for protection of various circuits.

The panel shall be provided with a 50x6 mm tinned copper earthing strip running throughout the length of the panel at the bottom. Panel shall be provided with space heaters with isolating DPN MCB, and thermostats. LED based lamps illuminating lights, complete with door switches; and 1 no. 6 pin 6/16 amps sockets with DPN MCB.

Panel shall be provided with fluorescent illuminating lamps with door switch and 6 point 6/16A, 230V AC socket with switch for maintenance purposes. Panel shall have removable lifting eye bolts for safe lifting from top during handling. Control power supply shall be provided from dual redundant feeders with auto change over scheme, surge protection devices and Power/Volt/AM meter.

The panel shall be provided with push buttons, indicating lamps, annunciators, indicating instruments, interlock/ deinterlock switches etc., required for the complete system. General details as specified in Vol. V, chapter 6 shall also be referred for engineering and design of relay panel/desk.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		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

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 2	OF 9

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.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 3	OF 9

3.3. PROCESSORS

3.3.1. The microprocessors shall be 32 bit, and Hot redundant.

3.3.2. Hot redundancy: PLC shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. This transfer from main processor to standby processor shall be bump less and shall not cause any disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processor as master and other as standby.

3.3.3. An authorized forcing facility shall be provided for changing the status of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements.

3.3.4. The standby processor shall be updated automatically in line with the changes made in the working processor.

3.3.5. In the event of any replacement of the processor, synchronization of the replaced processor shall be automatic upon live insertion.

3.3.6. The cycle time for input scanning, execution of logics, overheads and output scan shall not exceed 120 m sec.

3.3.7. The processor & memory shall be loaded up to 50% at normal conditions and maximum up to 60% under worst loading conditions.

3.3.8. The memories shall be field expandable.

3.4. INPUT / OUTPUT Modules

3.4.1. Input/output card assignments shall be modular i.e. no single card shall be assigned with more than one drive of a particular sub-system. The maximum number of channels per I/O module shall be as follows.

- Analog Input Module: 16
- Analog Output Module: 16
- Binary Input Module: 32
- Binary Output Module: 32
- Analog Input/output combined: 16
- Binary Input/output combined: 32

3.4.2. On line I/O replacement: All I/O cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off the power supply.

3.4.3. 10% spare capacity shall be ensured in each card channel assignment. Overall minimum 20% spare channels shall be provided.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 4	OF 9

3.4.4. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per "Data sheet A & B for PLC System". In case coupling relays are located in PLC Panel, the same shall be in PLC vendor's scope of supply.

3.4.5. Status feedback from MCC shall be in the form of potential free contact.

3.5. DATA BUS/ I/O BUS

3.5.1. The Data bus connecting PLC and HMI work stations shall be TCP/IP on Ethernet.

3.5.2. The Data bus and I/O bus communication medium shall be twisted pair shield copper conductor for indoor locations and those areas not subjected to induced signals. Repeaters/signal amplifiers shall not be used. Copper conductor cable used shall be Category-5 or better. The communication medium shall be Fibre optic cable in the event any portion of communication cable run is in outdoor or where distances are beyond 500 meters.

3.6. OPERATOR WORK STATION (OWS)

3.6.1. The OWS and Keyboard shall be desktop mounted and shall be used for controlling, monitoring and programming function.

3.6.2. Colour CRT(s) with keyboard and mouse shall be as per Data Sheet-A&B. CRT shall have graphic display facility.

3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 5	OF 9

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.~~

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 6	OF 9

- 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

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 7	OF 9

- 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

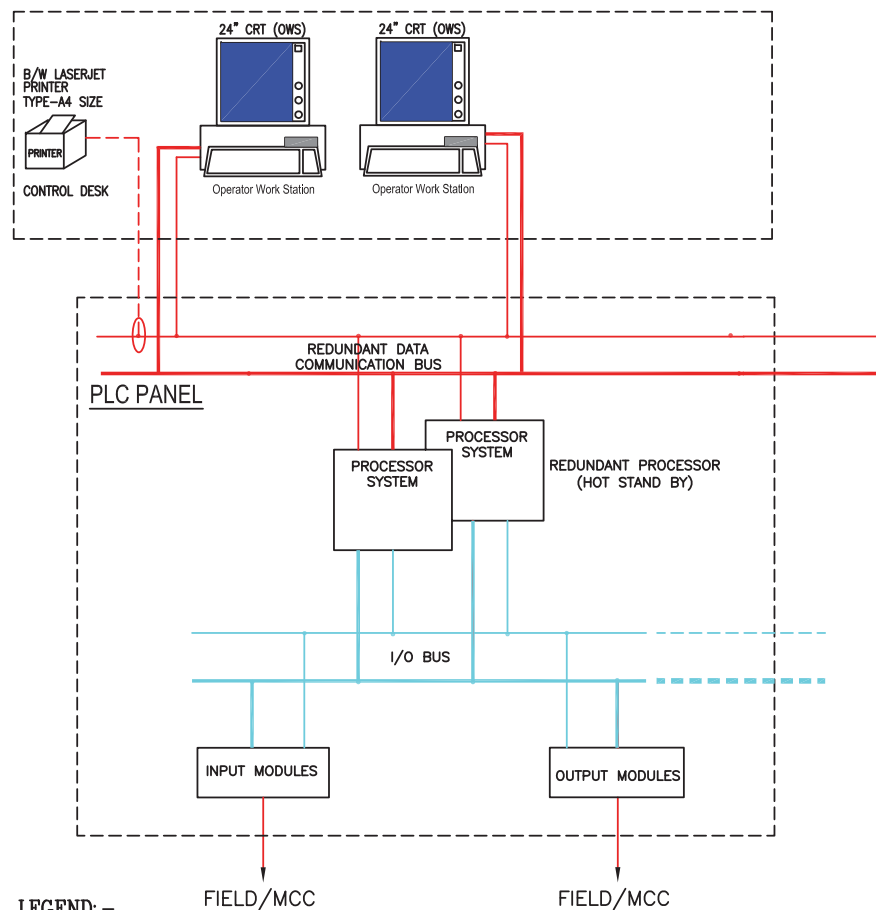
	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 8	OF 9

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.

10. APPLICABLE DATA SHEET FORMS

This document shall be read with the following data sheet forms :

- Data Sheet A & B for PLC system - PE-DC-999-145-I036-1
- Data Sheet C for PLC system - PE-DC-999-145-I036-2



LEGEND: -

PLC	- PROGRAMMABLE LOGIC CONTROLLER
DCS	- DISTRIBUTED CONTROL SYSTEM
UPS	- UNINTERRUPTED POWER SUPPLY
OWS/EWS	- OPERATOR WORK STATION/ ENGINEERING WORK STATION
HMI	- HUMAN MACHINE INTERFACE
NTP	- NETWORK TIME PROTOCOL
OPC	- OLE PROCESS CONTROL
MCCB	- MOULDED CASE CIRCUIT BREAKER
MCB	- MINIATURE CIRCUIT BREAKER
LCR	- LOCAL CONTROL ROOM

NOTES:

- 1) TABLE TOP OWS/EWS SHALL BE 24" OR AVAILABLE INDUSTRY STANDARD.
- 2) PLC SYSTEM SHALL HAVE REDUNDANCY IN PROCESSOR, POWER SUPPLY AND COMMUNICATION SYSTEM.
- 3) UPS POWER SUPPLY SHALL BE USED FOR PLC PANEL(S), OWS/EWS AND NETWORK COMPONENTS.
- 4) PLC PANEL SHALL HAVE PROVISION TO ACCEPT TIME SYNC. SIGNAL (NTP/IRIG-B) FROM MASTER CLOCK SYSTEM (BHEL SUPPLY).
- 5) INTERFACE WITH DCS SHALL BE THROUGH REDUNDANT COMMUNICATION LINK.



PROJECT:

1 X 660 PANKI TPS

DRG.NO.

9962-001-PE-405-PVI-B-153

TITLE:

PLC CONFIGURATION
(H2 GENERATION PLANT)

DATE

07.05.19

REV.NO.

03

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6

OF

6

	DATA SHEET FOR PLC SYSTEM		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 02	DATE: 19.07.2008
			SHEET 1	OF 1
Data Sheet No.: PES-145-36-DS1-0				
Data Sheet A & B				
DATA SHEET-A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)			DATA SHEET – B (TO BE FILLED BY BIDDER)	
GENERAL	PROJECT	1 x 660 MW PANKI		
	SERVICE			
	QUANTITY	☐ UNITISED ☒ COMMON		
	LOCATION	☒ INDOOR ☐ OUTDOOR		
PLC EQUIPMENT	MAKE / MODEL NO.	BIDDER TO INDICATE		
	PROCESSOR	REDUNDANT WITH HOT STANDBY		
	DATA BUS (HMI)	☐ COPPER WIRE ☐ FIBRE OPTIC		
	DATA BUS (I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC		
	DATA BUS (REMOTE I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC		
	FIELD CONTACTS INTERROGATION VOLTAGE	☒ 24 V ☐ 48 V		
	LOCATION OF COUPLING RELAYS	☒ MCC ☐ PLC PANEL		
	DESKTOP OWS QUANTITY	☐ ONE ☒ TWO ☐ _____		
	DESKTOP MONITOR TYPE	☐ 19" ☒ 24" TFT/CRT MONITOR		
	PRINTER (A4) - QUANTITY	INKJET _____ LASER B/W _____ COLOR INKJET _____ COLOR LASER _____		
	PRINTER (A4) - MODEL	☒ DOT MATRIX (1 No.) _____ LASER B/W _____ ☒ COLOR INKJET (1 No.) _____ COLOR LASER _____		
	PROGRAMMING / CONFIGURATION FACILITY	A) ☐ HAND HELD B) ☐ ENGINEERING SOFTWARE ☒ ONE OWS ☐ ALL OWS ☐ _____		
SAFETY STANDARD		_____		
	COMPUTER FURNITURE	☒ YES ☐ NO		
PANEL	QUANTITY	BIDDER TO INDICATE		
	CLASS OF PROTECTION	☐ _____		
	REMOTE I/O PANEL	☐ YES ☒ NO		
	COLOUR	AS PER IS-5 SHADE _____		
	BACK-UP DESK	☐ YES ☐ NO		
	MIMIC	☒ YES ☐ NO		
	CONTROL HARDWARE	☒ PB ☒ INDICATORS ☒ FACIAS _____ Nos. ☐ OTHERS		
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	☐ YES ☐ NO		
	PURPOSE	☒ CONTROL ☐ MONITORING		
	MEDIUM	☐ UTP ☒ FIBRE OPTIC ☐ OTHERS		
	TIME SYNCHRONIZATION SIGNAL FORMAT	☐ PULSE ☐ RS-485 ☒ IRIG-B		
	SOFTLINK	☐ MODBUS ☒ OPC		
	SERIAL LINK	COMMUNICATION PORT TYPE _____		
POWER SUPPLY INPUT FEEDER	PLC PANEL	a. 24V DC Charger for electronics		
	REMOTE I/O PANEL	b. 240V AC UPS for HMI/PRINTERS		



DATA SHEET FOR PLC SYSTEM

SPECIFICATION NO.:

VOLUME II B

SECTION D

REV. NO. 02

DATE: 19.07.2008

SHEET 1 OF 1

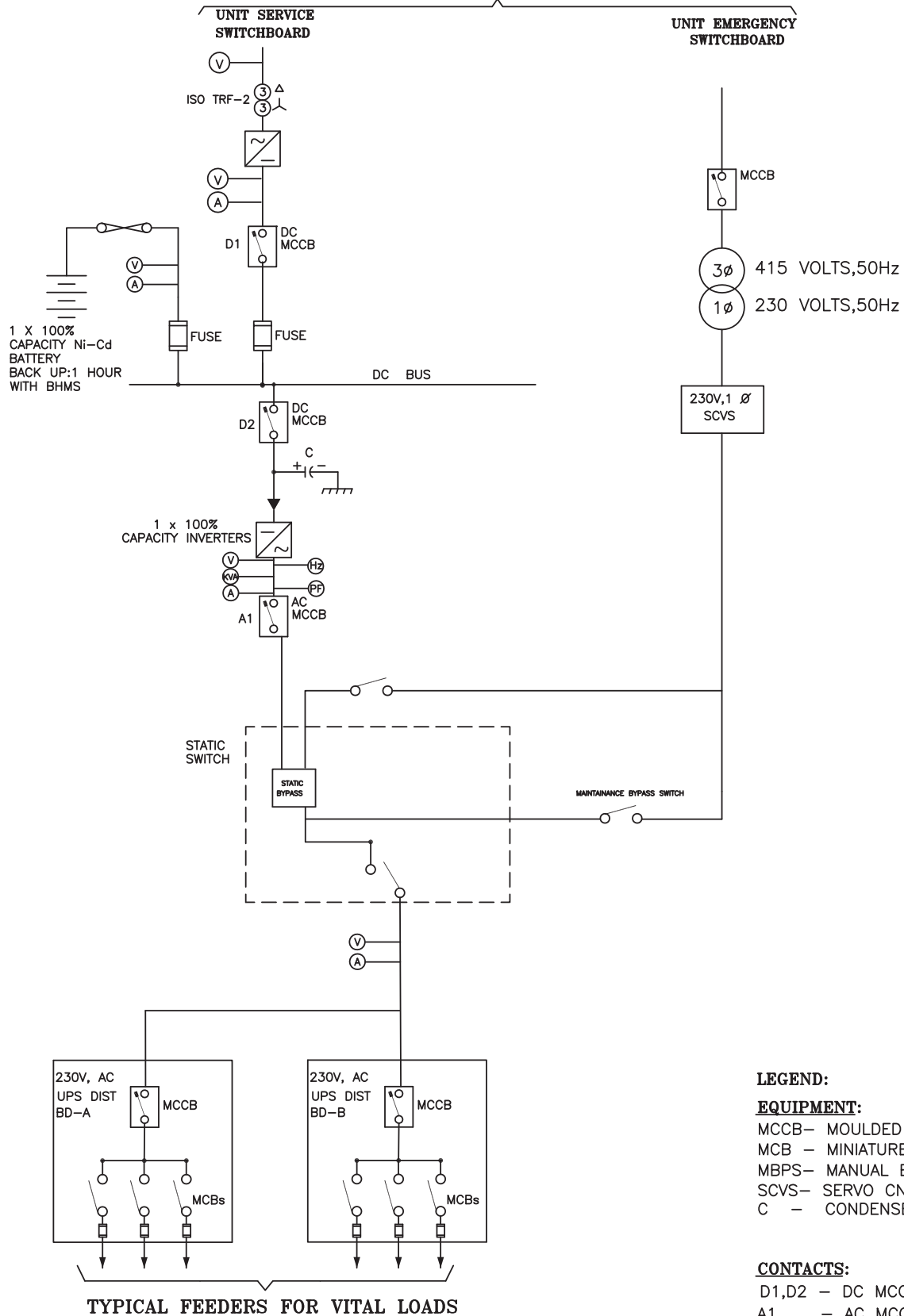
Data Sheet No.: PES-145-36-DS2-0

Data Sheet C

DATA SHEET – C
(TO BE FILLED BY BIDDER AFTER AWARD OF CONTRACT)

GENERAL *	PROJECT	
	SERVICE	
	QUANTITY	
	LOCATION	
PLC EQUIPMENT	MAKE / MODEL NO.	
	PROCESSOR	
	DATA BUS (HMI)	
	DATA BUS (I/O - CPU)	
	DATA BUS (REMOTE I/O - CPU)	
	FIELD CONTACTS INTERROGATION VOLTAGE	
	LOCATION OF COUPLING RELAYS	
	DESKTOP OWS QUANTITY	
	DESKTOP MONITOR TYPE	
	PRINTER (A4) - QUANTITY	
	PRINTER (A4) - MODEL	
	PROGRAMMING / CONFIGURATION FACILITY	
	SAFETY STANDARD	
		COMPUTER FURNITURE
PANEL	QUANTITY	
	CLASS OF PROTECTION	
	REMOTE I/O PANEL	
	COLOUR	
	BACK-UP DESK	
	MIMIC	
	CONTROL HARDWARE	
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	
	PURPOSE	
	MEDIUM	
	TIME SYNCHRONIZATION SIGNAL FORMAT	
	SOFTLINK	
	SERIAL LINK	
POWER SUPPLY INPUT FEEDER	PLC PANEL	
	REMOTE I/O PANEL	

415V 3PH 3 WIRE FEEDER



UTTAR PRADESH RAJYA VIDUYT UTPADAN NIGAM LTD.
1 X 660 MW PANKI TPS EXTN.

TITLE:- UPS SCHEME CONFIGURATION-B
FOR OFFSITE

DRG. No.	PE-DG-426-145-I004		
REV. No.	01	DATE	24.01.2019
SHEET	3	OF	4

24V DC CHARGER SYSTEM:

The locations where 24V DC Charger Systems provided are listed below:

- a) 24V DC SG/TG Charger
- b) 24V DC BOP Charger
- c) 24V DC charger for Water System DDCMIS
- d) 24V DC charger for AHP DDCMIS
- e) 24V DC charger for CHP DDCMIS
- f) 24V DC charger for FGD System DDCMIS

UPS SYSTEM:

The locations where UPS Systems provided are listed below:

- a) Main Plant UPS
- b) Water System Control Room
- c) AHP Control Room
- d) CHP Control Room

NOTE:—

All the relevant details like Sizing Calculations, GA and other details shall be reflected in the vendor document submitted by BHEL—EDN after Placement of order.

	UTTAR PRADESH RAJYA VIDUYT UTPADAN NIGAM LTD. 1 X 660 MW PANKI TPS EXTN.	DRG. No.	PE-DG-426-145-I004		
	TITLE:— UPS SCHEME	REV. No.	01	DATE	24.01.2019
		SHEET	4	OF	4

CHAPTER-7: UNINTERRUPTIBLE POWER SUPPLY SYSTEM & 24 V DC SYSTEMS**7.01.00 ELECTRICAL POWER SUPPLY**

7.01.01 The requirements of Electrical Power Supply system are specified herein on system basis.

The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification including tender drawings and Owner approved drawings during detailed engineering. All equipment and accessories required for completeness of this system shall be furnished by the Bidder whether these are specifically mentioned herein or not. All the equipments and sub systems offered shall be from reputed experienced manufacturers. All system cabinets, enclosures, & distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification at the manufacturer's works.

The Bidder shall furnish all required equipment cubicles and wiring required for conversion and/or stabilization of the power sources provided by the Owner to all other levels which may be necessary for meeting the individual requirement of equipment/system furnished by him including the panel/desk mounted equipment.

7.01.02 The power supply system shall be designed to meet the electrical power requirements of various C&I systems including DDCMIS. The Power Supply System shall be designed to give the voltage at approximate mid level of the tolerance band of the power supply modules/packs of Control System, when the charger is feeding the load. This shall also take in consideration the voltage drop in cables from DCDB to the control panels. In case the Power Supply Output of a charger exceeds the voltage band tolerated by the power supply modules/packs of Control System, provision for safe tripping of that charger is to be ensured.

7.01.03 The DC Power Supply for various sub-systems shall consist of one or more of the following configurations. The applicable configurations are as indicated in Appendix-1 to Part-A, Vol. V: -

- (A) DC power supply system shall comprise of two sets. Each set shall consist of 1 x 100% microprocessor controlled, intelligent, modular rectifier banks, Controller –one for each rectifier bank, 1 x 100% Nickel - Cadmium batteries for one 1 hour duty, 1 X 100% DC distribution board. 1x100% Microprocessor controlled Battery Health Monitoring System (BHMS)–common for both the sets.

The specifications for this configuration shall be as per Cl.No.7.02.01 to 7.05.00 as a minimum.

- (B) In case parallel redundant power supply module/power packs with 24 VDC output are used, the input power supply to the same can be either of 24 VDC/110 VAC/230 VAC/220 VDC, to be finalized during detailed engineering.

Bidder shall clearly bring out in the proposal the redundancy features along with configuration diagram, single line diagram & data sheets etc. and this shall be



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



finalized and subject to Owner's approval during detailed engineering.

- 7.01.04 Bidder shall also provide local power supply distribution boxes on as required basis for sub-distribution of all 230V AC and 24V DC utility feeders for various field mounted instruments/devices (e.g. Analysers etc.) supplied by the Bidder, Remote I/O Cabinets and also for the instruments/devices provided by the Owner. The power supply distribution box shall include necessary change over circuitry (as applicable), MCCB, switch fuse units, MCB, terminal blocks etc suitable for the application. The sub distribution of feeders in a local power D.B. shall be finalized during detailed engineering.

- 7.01.05** The UPS Power Supply for various sub-systems shall consist of one or more of the following configurations. The applicable configurations are as indicated in Appendix-1 to Part-A, Vol. V and chapter 3, 14, 15, 16, 19, 20, 21 & 22 of Part B of Technical specification.

Bidder shall clearly bring out in the proposal the redundancy feature along with configuration diagram, single line diagram and data sheets etc. & this shall be finalized subject to owner's approval during detailed engineering.

- (A) UPS System for critical system like DDCMIS & associated items, PLC & associated items, simulator, C&I Lab, Communication system etc. shall consist of 2 x 100% parallel redundant chargers and inverters with input isolation transformers, 2 x 100% Ni Cd battery bank for one (1) hour, Bypass line transformers & voltage stabilizer, static switch manual bypass switch, 2 x 100% ACDB, 1x100% Microprocessor controlled Battery Health Monitoring System (BHMS) and other necessary protective devices and accessories.
The specifications for this configuration shall be as per Cl. No. 7.06.00 to 7.10.00 as a minimum.
- (B) UPS system for non critical system like AAQMS, PSSS etc. shall consist of 1 x 100% charger and inverter, 1 x 100% Ni Cd Battery Bank for 1 hour, Bypass Line Transformers and Voltage Stabilizer, static switch, manual bypass switch, 2 x 100% ACDB, 1x100% Microprocessor controlled Battery Health Monitoring System (BHMS) and other necessary protective devices and accessories.
The specifications for this configuration shall be as per Cl.No.7.06.00 to 7.10.00 as a minimum.
- (C) On line UPS for DMS, OWS, Video conferencing System, cameras etc. with remote monitoring having a battery back up of 30 minutes as per Control System supplier's standards.

The UPS shall be designed at a load factor of 0.8 lagging at 50 deg C keeping a 10% design margin over the actual load requirement.

- 7.01.06 The batteries for 24VDC power supply systems shall conform to requirements specified at Cl. No. 7.11.00.
The batteries for UPS system for configurations as per clause 7.01.05 (A) and (B) shall conform to requirements specified at Cl. No. 7.11.00. The batteries for UPS system for configuration as per clause 7.01.05 (C) shall be Sealed Maintenance free type as per Control System Supplier's Standard.

7.02.00 DC POWER SUPPLY SYSTEM (24 V)



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



- 7.02.01 Microprocessor based, Intelligent, Modular Power Supply
- 7.02.02 Microprocessor based, Intelligent, Modular Power Supply shall be sized for continuous duty to meet 100% load requirements and keep the connected battery fully charged in float mode.
- 10% design margin has to be considered over and above the load requirement. Either of the bank of rectifier modules shall be able to re-charge the fully discharged battery within 8 hours. It shall also be possible to discharge batteries periodically manually. Each rectifier bank shall be provided with N+1 rectifier modules and the maximum numbers of rectifier modules shall not be more than 25 Nos. The exact sizing of the rectifiers in one bank shall be subject to Owner approval during detailed engineering. It shall be ensured that all rectifier modules in one rectifier bank shall be of same rating and not more than three ratings of rectifier modules shall be used in various rectifier banks.
- Provision for manual boost charging with isolation of loads shall be provided. While selecting the components and finalizing the cooling arrangements, Bidder to note that these rectifier modules are required to operate at 30-40% of the rated load for most of the time. While sizing, the temperature derating factor as applicable, is to be considered for arriving at the rating of the modules as per Bidder's manufacturing standard if the modules are rated for lower than the 50 deg. C ambient. For the rectifier bank, matching controller along with applicable software shall be provided to meet system requirements under all modes of operation." 24 V DC system rating shall be submitted by bidder for approval considering full load operation.
- 7.02.03 The rectifier module shall be microprocessor controlled, IGBT/ Power MOSFET based, high frequency with active load sharing, designed for single and parallel operation with battery and shall have automatic voltage regulators for a close voltage stability even when AC supply voltage and DC load fluctuates, effective current limiting features, front access design, programmable temperature compensation feature for battery charging and filters on both input and output to minimise harmonics. The rectifier module output regulation shall be $\pm 1\%$ or better from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications/display on rectifier panel, alarms along with relevant analog measurements shall also be provided by employing RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for use in DDCMIS. Further isolated 4-20 mA signals shall be provided for important parameters like rectifier bank voltage, rectifier bank current, battery voltage, battery current, DCDB Voltage, DCDB current etc. The list of alarm output & 4-20 mA signals shall be as approved by Owner during detailed engineering. Necessary provision shall be done in DDCMIS end also.
- 7.02.04 The rectifier module shall be fed from 415V AC, 50 HZ, 3 phase, 3 wire system.
- 7.02.05 "Float/Boost" charge functions shall be provided with alarm/indications. In Boost mode, each of the chargers shall be able to re-charge the fully discharged battery within 8 hours. However, each charger shall be able to supply full load current requirements plus the battery charging current in boost mode. Complete operation shall be in auto mode. Operator intervention shall not be required for 24 V DC system operations
- 7.02.06 The rectifier module shall be current limited for circuit protection and protection of battery from overcharge. The current limit shall be continuously

programmable.

- 7.02.07 The rectifier module shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energized.
- 7.02.08 The full load efficiency of rectifier module at nominal input and output shall be at least 90%. The ripple content shall be limited to +/- 0.5 % of output voltage.
- 7.02.09 The Controller shall be microprocessor controlled for monitoring & control of rectifier modules with features viz. Auto/Manual battery discharge test, battery reserve time prediction, energy management, float/boost mode control etc.
- 7.02.10 All Software as required for smooth operation and monitoring of rectifier modules in conjunction with Controller & BHMS shall be provided by the Bidder.
- 7.02.11 Bidder shall furnish the equipment complete in all respects along with rectifier module rating & voltage drop calculations, supporting curves/data etc.
- 7.02.12 MCCB shall be provided at input, output, battery side, & DCDB side etc with ON, OFF & Trip indication.

7.03.00 **DC Distribution Board (DCDB)**

Redundant DC feeders (one from each DCDB) shall supply each of the connected loads. The exact design, rating & number of feeders of the each redundant DCDB shall be as finalised during detailed engineering and as approved by Owner. However, 25% spare feeders (min. 1 no. of each type & rating) with LED indication, MCB and fuses for each rating shall be provided in each DCDB.

7.04.00 **Battery Health Monitoring System (BHMS)**

BHMS, wherever applicable, shall include microprocessor based hardware and software to monitor the condition of each battery cell of 24 V DC systems & UPS battery banks on-line. With BHMS it shall be possible to measure & analyse the minimum and maximum voltage values of each battery-cell so that any damage to battery shall be prevented by pro-active maintenance. BHMS shall communicate with the DDCMIS and provide alarms as finalized by Owner during detailed engineering.

Complete hardware like detector units, Battery clips, cables, monitor (power control unit) and other accessories etc as required to complete the system shall be provided by bidder. LED indication shall be provided on detector units for power, alarm and RUN indication etc. Data from Online Battery Health Monitoring System shall be communicate/transferred to respective DDCMIS/respective PLC for Monitoring and analysis using different protocol like RS485 Modbus/OPC etc.

- 7.05.00 Power Supply shall be sized to meet connected load requirements and keep the connected battery full charged in Float/ Boost mode. The rectifier module output regulation shall be $\pm 1\%$ or better from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications/display on the panel, potential free contacts for alarms like O/P



voltage high & low, AC Input supply failure, battery feeding the load etc shall also be provided for use in respective control system i.e., PLC/Remote IO etc. Further isolated 4-20 mA signals shall be provided for important parameters like rectifier module voltage, rectifier bank current, battery voltage etc. The list of alarm output & 4-20 mA signals shall be as approved by Owner during detailed engineering. The exact design, rating & number of feeders of the DCDB shall be as finalised during detailed engineering and as approved by Owner. However, 25% spare feeder (min. 1 no. of each type & rating) with LED indication, MCB, fuses for each rating shall be provided in each DCDB.

7.06.00 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

The UPS shall be designed at a load factor of 0.8 lagging at 50 deg C keeping a 10% design margin over the actual load requirement. UPS load rating shall be submitted by bidder for approval considering full load operation.

The UPS System shall meet the following requirements as a minimum.

If UPS KVA rating is applicable at a lower ambient temperature than specified 50 deg. C, the Bidder shall consider a derating factor of at least 1.5%/deg. C for arriving at the specified UPS capacity at 50 deg. C ambient. The UPS shall have an overload capacity of 125 % rated capacity for 10 minutes, 150 % rated capacity for 60 seconds, 200% for 10 seconds and 300% for 4 milli-seconds. The inverter shall have sufficient capability to clear fault in the maximum rated branch circuit, limited to 8 percent of finally selected UPS Capacity.

Acoustic noise at rated linear load shall be < 75 dBA at 1 meter distance from UPS as per ISO 3746.

The industrial grade UPS system for main plant & for each individual BOP/ offsite package shall include the following equipment:

Sr. No.	Descriptions	Configuration for UPS of main plant DDCMIS Package and BOP/Off-site DDCMIS package.	Configuration for UPS for Off site / BOP package PLC based.
1.	100% capacity of IGBT based PWM Inverter with output Voltage, current, frequency, KVA & KW digital display/meter.	2 nos.	2 nos.
2.	100% capacity static switches with input Voltage, current, frequency digital display/meter at bypass line.	(As required) 2 no. (Min)	(As required) 2 no.(Min)
3.	Manual by-pass switch	1 no.	1no.
4.	100% capacity floats-cum-boast full wave Chargers	2 nos.	2 nos.
5.	Battery Set with accessories each	2 set for 1 hour back-up at 100% of	2 set for 1 hour back-up at 100% of

		selected UPS rating.	selected UPS rating.
6.	Step-down transformer (415 V, three phase , to 230V, single phase) of required capacity)	1 no	1 no
7.	Static Voltage Stabilizer with input & output ON Red indication and input & output Voltage, current, frequency digital display/meter.	1 set	1set
8.	Input isolation transformer with input & output ON red indication and input Voltage, current, frequency digital display/meter. Out put isolation transformer	1 no each	1 no each
9.	A.C. Power Distribution Panels (including 20 % spare feeders on each panel with 2 nos. minimum spare feeder of each rating) and digital type Ammeter, Voltmeter, Frequency meter, PF meter, Watt meter & VA meter	2 sets (Quantities of feeders shall be as on required basis).	2 sets (Quantities of feeders shall be as on required basis).
10.	Interconnecting Armored FRLS ST2, PVC type C insulated Copper conductor Cable between UPS equipment & battery, UPS & ACDB, ACDB & loads.	As required	As required
11.	MCCB (At input, output, battery side, bypass & ACDB side etc) with ON, OFF & Trip indication.	1 no. each	1 no each
12.	Online Battery Health Monitoring System	1 set	1 set in case of UPS rating more than 10 KVA.
13.	Battery Junction Boxes with MCCB, Voltmeter & Current meter.	1 set each	1 set each
14.	Any other equipment necessary for completion of the system shall be provided by bidder.		

All equipment, enclosures and accessories for UPS system shall be designed, arranged assembled and connected in accordance with the requirements of this specification.

7.06.01 Chargers

- 7.06.01.01 The chargers shall be self regulating, solid state silicon controlled, full-wave rectifier type designed for single and parallel operation with battery and shall have automatic voltage regulators for close voltage stability even when AC supply voltage fluctuates, effective current limiting features, filters to minimise harmonics. The charger should be capable to fully charge the required batteries as well as supply the full rated load through inverter. Furthermore the charger should be able to re-charge the fully discharged battery within 8 hours automatically. The charger output regulation shall be $\pm 1\%$ from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency. In addition to indications/display on charger panel, alarms along with relevant analog measurements shall also be provided by employing RS 485 Port Modbus Protocol /Ethernet TCP/IP protocol for use in DDCMIS. The list of alarm output & 4-20 mA signals shall be as approved by Owner during detailed engineering.
- 7.06.01.02 The charger shall be current limited for charger circuit protection and protection of battery from overcharge shall also be provided. The current limit shall be continuously adjustable. The chargers shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energised.
- 7.06.01.03 The chargers shall be fed from 415V AC, 50 HZ, 3 phase, 3 wire system. Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration.
- 7.06.01.04 The minimum full load efficiency at nominal input and output shall be 90%. The ripple content shall be limited to $\pm 2\%$ without battery and $\pm 1\%$ with battery of Charger output voltage.
- 7.06.01.05 The UPS battery shall have sufficient amp-hour capacity to supply the steady state KVA rating of the UPS specified for 60 minute, irrespective of the actual load on UPS.
- 7.06.01.06 The UPS system shall be capable of operating without D.C. battery in circuit under all conditions of load and the performance of various components of UPS like inverter, charger, static switch etc. shall be guaranteed without the battery in circuit.
- 7.06.01.07 The UPS system design shall ensure that in case of failure of mains input power supply to one of the chargers, the other charger whose mains input power supply is healthy, shall feed to one or both the inverters as the case may be as per manufacturer's standard practice & continue to charge the D.C. battery at all load conditions. The Bidder should note that this situation should not in any way lead to the discharge of the D.C. Battery.
- 7.06.01.08 Voltage control shall be step less smooth and continuous. Float & equalizing control shall have an adjustable range of $\pm 5\%$.

7.07.00 Static Inverters

- 7.07.01 The static inverter shall be of continuous duty, solid state IGBT type using proven Pulse Width Modulation (PWM)/Quasi square wave/step wave technique consisting of static filters, integrated control modules including necessary oscillators, voltage regulators, current limiting and surge suppression. Ferro-



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



resonant types Inverters are not acceptable. The nominal voltage output shall be 230 Volts, Single phase, 50 Hz.

- 7.07.02 The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc.
- 7.07.03 The steady state voltage regulation shall be $\pm 1.5\%$ and transient voltage regulation (on application/removal of 100% load) shall be $\pm 10\%$. Time to recover from transient to normal voltage shall not be more than 50 msec. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination shall be better than $\pm 0.5\%$ (automatically controlled).
- 7.07.04 The total harmonic content shall be 5% maximum and content of any single harmonic shall be 3% maximum. The inverter efficiency shall be at least 90% on full load and 80% on 50% load. The synchronisation limit for maintenance of synchronisation between the inverter and stand by AC source shall be 48-52Hz, field adjustable in steps of 1 Hz.
- 7.07.05 On occurrence of a fault in branch circuit, the inverter shall be capable of clearing the highest rated branch circuit fuse in 4 milli-seconds or less.
- 7.07.06 The inverter shall be protected against overload, short circuit, 100% loss of load, as well as excursions, loss or restoration of D.C. input voltage and synchronizing voltage
- 7.07.07 The D.C. input current shall never exceed twice the full load current except for a short circuit within the inverter.
- 7.07.08 For any value of the load and load power factor drawn by the equipment served, the inverter shall not impose on D.C. source any voltage oscillations in excess of 5 volts (RMS total all frequencies) or any current oscillations in excess of 3 percent (RMS total all frequencies) of the D.C. current at full load.
- 7.07.09 The inverter will be self protecting against A.C. and D.C. Transients, voltage surges and steady state abnormal voltage and currents likely to be encountered in the plant.
- 7.08.00 **Static Switch and Manual Bypass Switch**
- 7.08.01 The static switch shall be solid-state type using SCR for performing the function of transferring UPS loads automatically without any break from (i) faulty inverter to healthy inverter in case of failure of one of the two inverters and (ii) from faulty inverter to standby AC source in case of failure of both the inverters. The transfer time shall be $\frac{1}{4}$ cycle maximum in synchronous mode.
- 7.08.02 Static transfer switch shall be furnished with contact to alarm failure of the alternate source or opening of any fuse protecting the static switch.
- 7.08.03 The UPS bus shall be monitored by two voltage detectors. One fast acting circuit shall be used for detecting a complete and instantaneous voltage loss while the other slower acting averaging circuit with adjustable trip level shall be employed

to detect voltage deviation beyond selected limits. Both voltage detector circuits shall automatically initiate operation of transfer switch.

7.08.04 Transfer Inhibit - Automatic or manual transfer from inverter to stand-by A.C. source vice versa shall be inhibited when the inverter frequency is not synchronized to the alternate source-

i) Retransfer to Normal

ii) The return to inverter mode shall be manual in all cases.

iii) Manual transfer shall be initiated by push button actuation.

7.08.05 Manual bypass switch shall be employed for isolating the UPS during maintenance. The switch has also the facility of by-passing both the static transfer switches during start-up at the option of the operator.

7.08.06 The UPS bus shall be monitored by two voltage detectors. One fast acting circuit shall be used for detecting a complete and instantaneous voltage loss while the other slower acting averaging circuit with adjustable trip level shall be employed to detect voltage deviation beyond selected limits. Both voltage detector circuits shall automatically initiate operation of transfer switch. The Manual bypass switch and required disconnect devices shall be furnished duly mounted and wired in enclosure , furnished by the Bidder.

7.08.07 Continuous and overload capacity of the switches shall be equal to 100% of the continuous and overload rating of each inverter. Peak Capacity shall be 1000% of continuous rating for 5 cycles.

7.09.00 **Step Down Transformer and Voltage Stabiliser**

One 415V three phase to 230V, single phase transformer along with associated voltage stablizer shall be furnished with each UPS system. source.

The overload capacity of the transformer and voltage stabilizer shall not be less than 300% for 200 millisecond duration. The voltage stabilizer shall employ servo-controlled circuitry and shall maintain the specified output voltage for 0-100% load with maximum input voltage variations as indicated above. The efficiency of the stabiliser shall be 95% or better. Class of insulation of wound components like transformers etc shall be class H with temp rating up to class B.

The type and other details shall be subject to Owner's approval.

7.10.00 **AC Distribution Board (ACDB)**

The distribution boards shall be fixed type, of modular design in freestanding gasketed sheet steel enclosure conforming to IP-54. Sheet steel thickness shall be 2 mm minimum. Each module shall be housed in a separate compartment complete with individual front access door. Working height shall be limited to 1800 mm from floor level. A full height vertical cable alley shall be provided in each panel to facilitate module wiring. The alley shall be liberally sized and shall



have removable cover at the front. Removable back covers shall be provided at the back of the panels.

The details of the AC distribution board, i.e. exact, rating and number of feeders etc. of the 2x100% ACDB shall be as approved by Owner during detailed engineering. Each feeder shall have fast acting semi conductor fuse, MCB & LED indication for ON status. ACDB shall be designed to cater to the requirements of all the loads. The number of feeders (including 20 % spare feeders on each panel with 2 nos. minimum spare feeder of each rating) and rating of each feeder shall be to suit the individual load keeping in view the fuse clearance capability of UPS system already stipulated and shall be as finalised during engineering. No price implication is admissible for the number ratings of feeders as decided during engineering and owners decision in this shall be final.

7.11.00 Batteries

The batteries shall be heavy duty valve regulated Nickel-cadmium type and shall be sized for one hour of full load operation at 100% of selected UPS rating irrespective of the actual load on UPS and 24 VDC Charger system during non-availability of AC supply / chargers. The Ni-Cd batteries shall conform to IS: 10918. For sizing calculation, design margin, an aging factor of 0.8 and a temperature correction factor as per manufacturer's standard at 4 deg. C electrolyte temperature (Based on temperature characteristics curve to be submitted by the Bidder at a temperature of 4 deg. C), Capacity factor, float correction (if applicable) shall be taken into consideration. The sizing of the battery shall be as approved by Owner during detailed engineering. The Bidder shall consider a voltage drop of 2.5V from battery room to DCDB and DCDB to load, while sizing the battery for 24 V DC Charger System and 4V from battery room to the inverter input while sizing the battery for UPS System.

Nickel coated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively Nickel coated to prevent corrosion.

All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds.

7.11.01 The following information/details shall be indelibly marked on outside of each cell:-

- i) Manufacturers' name and trade marks.
- ii) Country and year of manufacture.
- iii) Manufacturer type designation.
- iv) AH capacity at 5 & 8 hour discharge rate.
- v) Nominal voltage
- vi) Voltage for float operation at 27°C with tolerance of $\pm 1\%$.
- vii) Serial Number.

For detail Battery & Battery Charger specification refer Chapte-20 of Volume-IV.

7.11.02 One complete set of all accessories and devices required for maintenance and testing of batteries shall be supplied for each set of the batteries of each unit/plant auxiliary system. Each set include at least the following:



a)	Hydrometer	5 Nos
b)	Cell testing voltmeter (3-0-3 V)	5 Nos
c)	Alkali mixing jar	5 Nos
d)	Rubber aprons	5 Nos
e)	Pair of rubber gloves	5 Nos
f)	Set of spanners	5 Nos
g)	No smoking notice for each battery room	2 Nos
h)	Goggles (industrial)	5 Nos
i)	Instruction card	10 Nos
j)	Minimum and maximum temperature indicator for battery room	1 No.
k)	Cell lifting facility	1 Set
l)	Vent Caps	2 set
m)	Terminal Bolts & Washers	1 Set
n)	Plastic Filling Bottles	10 Nos.
o)	Alkali resistant funnel & Mugs	10 Nos.
p)	Electrolyte testing kit	1 No

7.12.00 AUXILIARY EQUIPMENTS

- 7.12.01 All required auxiliary equipment/materials as finalised during detailed engineering shall be furnished with each rectifier bank, UPS & battery bank and shall include as a minimum various meters (AC/DC voltage/current, kVA, power factor, frequency meters etc), circuit breakers, selector switches, push buttons indicating lights, ground detector system, battery accessories like (inter cell connectors, inter step connectors, battery racks etc.) isolated 4-20 mA signals for important parameters and potential free contacts for important alarms shall be provided for use in DDCMIS.
- 7.12.02 Manual Discharge Resistance bank of adequate capacity for UPS & 24 V DC Power Supply System batteries as indicated in Appendix-1 to Part-A shall be provided by the Bidder.
- 7.12.03 Not Used
- 7.12.04 Cell booster charger shall be provided with main plant's UPS & 24 V DC charger system batteries and UPS & 24 V DC charger system batteries for BOP's each DDCMIS set to charge the new & sick cell for revival of cell. The cell booster shall be built in separate portable panel.
- 7.12.05 Class of insulation of wound components (All transformers, chokes/inductances etc.) shall be class H with temp rating up to class B.
- 7.12.06 The UPS, 24 V DC system equipment and the complete system shall have surge withstanding capability (SWC) to meet the requirements of ANSI C 37.90a – IEEE Standard 472 –1974. UPS should be provided with Class C type surge protection device. The Class C type surge arrester should be single MOV type , pluggable, should have fault indication and should be tested as per IEC 61643-1 to withstand 40KA 8/20 μ s pulse. The arresters should have potential free contact to ensure maintainability.
- 7.12.07 Lamp / Space Heaters / Receptacles
- a) The panels shall be provided with:
- i) Internal illumination lamp with door switch.



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



ii) Space heater with thermostat control.

ii) 3-pin 6A receptacle with plug.

b) Lamp, heater and receptacle circuits shall have individual switch fuse units.

7.12.08

UPS Signal interfacing with DDCMIS/DCS & PLC

- a) The bidder shall provide alarms and status indications, current, voltage, frequency, PF etc through serial link with MODBUS or another compatible protocol.
- b) The Bidder shall furnish 4-20 mA signals to DDCMIS/DCS/PLC for the following:
 - i) Inverter A & B output voltages
 - ii) Inverter A & B output currents
 - iii) Inverter A&B output frequency
- c) List of alarms (min.) to DDCMIS/DCS/PLC through potential free contacts shall be as follows:-
 - i. Rectifier – 1 Trip.
 - ii. Inverter – 1 Trip.
 - iii. UPS battery low.
 - iv. Rectifier – 2 Trip.
 - v. Inverter – 2 Trip.
 - vi. Load on static Bypass.
 - vii. Static Bypass failure
 - viii. ACDB – 1 Incomer Tripped.
 - ix. ACDB – 2 Incomer Tripped.
 - x. UPS – 1 Fan Tripped.
 - xi. UPS – 2 Fan Tripped.

The above alarm shall also be duplicated in UPS panel. Alarm fascia shall be provided on each charger and inverter panel, complete with proper actuating devices, circuitry and legends to incorporate above minimum requirement.

7.13.00

BATTERY RACKS

Battery racks of mild steel construction to bear 150% over load, anti acid paint etc. in accordance with applicable codes and standard shall be provided. AISC Specification shall apply in the absence of another design specification.

7.14.00

DRAWINGS/DOCUMENTS REQUIREMENTS

Bidder shall furnish the power supply distribution scheme, single line diagram, all calculations such as Rectifier Modules / UPS Charger / Inverter rating calculations, battery sizing calculation etc. for DC system as well as for UPS during detailed engineering for Owner's review and approval.

7.15.00

CABINETS / ENCLOSURES



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



The Construction details for Power Supply System Cabinets/ Enclosure/Racks shall conform to the requirements of the following paragraphs.

- (1) The Construction details for UPS & 24 V DC charger system cabinets/enclosure shall conform to the requirements indicated in chapter 6.
- (2) The temperature rise inside all the cabinets/enclosures shall not exceed 10 deg.C above ambient temperature. The cabinets shall be IP-32 protection class.
- (3) The Colour shade of Panels exterior/interior shall be as per Vol. V, Part B, Chapter 6.

7.16.00 COOLING SYSTEM

If the equipment supplied requires forced air cooling, the cooling system furnished shall meet the following requirements:

- (1) Reserve cooling equipment shall be furnished for each assembly. Reserve fan capacity shall be equal to 100 percent of cooling fan requirements for full load operation with only one bank of rectifier/inverter in service at the specified maximum ambient temperature.
- (2) Completely independent duplicable wiring and control systems shall be provided for the normal cooling fan system and the reserve cooling fan system.
- (3) Each cooling fan shall normally run continuously and shall be powered from the output of the inverter whose enclosure it serves (for cubicles housing inverters). For other cubicles, fan power supply shall be as finalised during detailed engineering. Each cooling fan supply circuit shall be separately fused.
- (4) Each cooling fan shall be equipped with a switch having an alarm contact that closes upon failure of airflow or rise of temperature.

7.17.00 Grounding

Normal, AC power supply will be grounded at the source. For grounding other than this, I/P and O/P isolation transformers shall be furnished with the UPS and 24 V DC charger system.

Panels shall have fully rated ground bus with two ground terminals, one at each end. Each terminal shall comprise two-bolt drilling M10 G.I. bolts and nuts to receive Purchaser's ground connection of 50 x 6 mm G.S. flat.

7.18.00 Wiring / Cabling

- a) The panels shall be completely wired up. All wiring shall be done with flexible, 1100V grade, PVC insulated wires with stranded 2.5 Sq.mm copper conductors and routed through wiring troughs. Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block No., terminal number as per approved wiring diagram.



In case of Control wiring to be terminated at connectors on Card Section it shall be done with flexible, 1100V grade, PVC insulated wires with stranded 0.5 Sq.mm copper conductors

- b) Panels shall have removable gland plate for cable entry. All incoming/outgoing cables shall be terminated in suitable terminal block.
- c) Control terminal blocks shall be box-clamp type, minimum 10 Sq.mm. 20% spare terminals shall be furnished.

7.19.00 Nameplate

- a) Engraved nameplates shall be provided for each panel and for each equipment/device mounted on it.
- b) The material shall be anodized aluminium / lamicoid, 3 mm thick, with white letters on black background.
- c) Nameplates shall be held by self-tapping screws. The size of nameplates shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.
- d) Nameplates for panels shall be provided both on the front and rear.
- e) Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.
- f) Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument/device number. The number may be painted on or adjacent to the instrument or device case.
- g) Caution notice on suitable metal plate shall be affixed at the back of each panel.

7.20.00 Tropical protection

- a) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus insects and corrosion.
- b) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

7.21.00 SITE TESTS

The Bidder shall also carry out the site tests on Uninterruptible Power Supply System and 24V DC Power Supply System for demonstrating the specification requirements. In case any other site test is required to be conducted as a standard practice of the Bidder and mutually agreed between the Bidder and the Owner, the same shall also be carried out.

7.22.00 Tests on UPS System

- a) Type & routine test for various components.



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



b) Burn-in Tests and Temperature Rise Tests

Each component of UPS & 24 V DC system shall undergo burn-in test for 50 hours continuously. All equipment provided under this specification shall be operated under rated conditions and maximum ambient temperature for not less than 120 hours prior to release for shipment. In addition, static switches shall be subjected to not less than 1000 "Transfer/retransfer" cycles at full load. During temperature rise test final rise in temperature of semiconductor and devices will be measured at rated conditions and the temperature shall be within stipulated limits for components. After manufacture, the system shall be subjected to routine tests as per standards. The bidder shall indicate all these routine tests in their offer. These shall include insulation resistance test, die-electric with stand test (by applying voltage of 2000 V for one minute) noise test, interference noise test, surge with stand capability.

- c) Burning test on PCBS - Assembled PCBS shall be tested at 70°C for 72 hours in loaded condition.
- d) Rapid temperature cycling test at 70°C and 0°C for 30 minutes at each temperature - 5 such cycles.
- e) Functional tests to demonstrate compliance with all specified requirements and published. Specifications such as frequency, regulation, voltage regulation, current limiting, fuse clearing capability of inverters, demonstration of phase and frequency control of inverter for synchronization with range of adjustments transfer and retransfer of static switches under influence of under voltage and over current, tests on chargers, batteries and other system component to confirm compliance with specification.

Type test certificates of any equipment shall be furnished, if so desired by the Purchaser. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

For detail test on Battery & Battery Charger specification refer Chapte-20 of Volume-IV.

7.23.00 QUANTITIES

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.



1 x 660 MW - Panki Thermal Power Station "

Bidding Doc. No. : 14A14-SPC-G-0001



All the peripherals shall conform to the following minimum requirement but the exact make & model shall be as approved by Owner during detailed engineering. The LAN to be provided under HMIPIS shall support TCP/IP protocol (Ethernet connectivity) with OPC RDI for interface with PLCs/other systems and shall have data communication speed of min. 100 MBPS. All network components of LAN and Servers/ Workstations shall be compatible to the LAN, without degrading its performance. The redundant LANs of all the units shall be connected through suitable network components. It shall be ensured that failure of this network component(s), shall in no way affect individual unit's operation monitoring & control in any way.

3.49.02 The Servers/Workstations/PCs/Laptop to be provided by the Bidder should be latest available in the market at the time of supply to prevent early obsolescence and shall be subject to Owner's approval. The software packages to be included with the server/OWS/PCs shall also be the latest version available at the time of supply.

3.49.03 However for Servers and Historians / Station LAN Server/ Programming station/NMS Server/operating work station/PC/Laptops, the hardware shall conform to the following minimum requirements:

SI No	Features	Servers/ Workstations for Information functions / Station LAN Server/ Programming station/NMS Server	Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.) and PC
1	Processor	Intel Xeon Six (6) Core 64 bit Processor capable 3.6 GHz with 16MB L3 cache memory per processor, Dual independent 1333 MHz system bus (2 way SMF) or better.	64 bit/32 bit - On board Intel - Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
2	Memory	64GB ECC DDR - 3, 800 SDRAM.	8 GB DDR3 RAM
3	Drives	HDD - RAID 5 (1000 GB) Ultra 320 SCSI adaptors with internal storage capacity 3.6 TB DVD/CDROM - 24X CD- RW/DVD IDE combo USB - 4 ports DAT - 36 / 72 GB 2048 MB Graphic Accelerator	1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher. 2048 MB Graphic Accelerator.
4	Monitor (colour)	LED based 24" sized Monitors. with non-interfaced refresh rate min. 75 Hz. Full HD resolution 1920 X 1080, 256 colours with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response	LED based 24" sized Monitors. with non-interfaced refresh rate min. 75 Hz. Full HD

		time.	resolution 1920 X 1080, 256 colours with MRPII ompliant, viewing angle 178° vertical & Horizontal and fastest response time.
5	RAID	SAS-channels, hardware RAID level 5 implemented	
6	Redundant hot swappable power-supply	2 nos.	
7	Removable bulk storage drive (DVD)	6GB (minimum)	
8	Removable Bulk Storage Media for above (with each server/work-station)	10 nos	
9	DVD R/W	16x or higher	16x or higher
10	Intelligent UPS (on line) with all accessories and software for remote monitoring for each workstation/server	1 no. each with 30 mins. Battery backup on machine load and 10% design margin at full load.	1 no. each with 30 mins. Battery backup on machine load and 10% design margin at full load.
11	Keyboard	ASCII	ASCII
12	Pointing Device	Optical Mouse	Optical Mouse
13	Accessories	Industrial grade furniture as approved during detailed engineering	Industrial grade furniture as approved during detailed engineering
14	Additional general purpose software (for using over network by servers/workstations/PCs)	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/antivirus, etc. (like "Norton System Works Latest edition")	
15	Software	Windows 2008/2012/latest edition server version standard /Enterprise Edition or latest & proven version of Windows Operating system.	Windows XP/7 Professional or latest & proven version of

		General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus software with IPS, etc. Application engineering & HMI software - to suit project Specific requirement.	Windows OS with Multimedia. Third party operating system, graphical users interface and software, if required. General MS Windows latest, MS-Office Professional, Adobe-Acrobat, anti-virus software with IPS, AutoCAD etc. Application engineering & HMI software - to suit project Specific requirement.
16	Misc. Requirements	i. 1 Parallel port ii. 4 nos. USB 3.0/2.0 ports. (2 nos. on front side). iii. 4 – 10/100/1000 MB/1GB network ports iv. Two non-boards and two added v. External SCSI port vi. Dual hot plug power supplies vii. Dual Hot plug fans viii. 2 PCI Express slots (1x4 lane and 1x8 lane) ix. 2 PCI X slots (64bit/100MHz) x. 2 PCI slots (one 32bit/33MHz, 5V & one 64bit/66Mz) xi. Hot Redundant Server shall be provided, wherever required. xii. Backup & Disaster Recovery software.	System chipset: Intel Express. 2 x RS – 232 ports. 1 x parallel port. 4 nos. USB 3.0/2.0 ports. (2 nos. on front side). 1 x 16 X or better DVD R/W Drive. 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade). 2 nos. graphic output cards minimum. Sound card & Internal speakers. Wireless internet & Blue tooth Interface. Redundant power supply (In built).

The supervisory function of HMIPIS like log, calculations, shall be implemented in redundant Server/Information workstation, so that no functions are lost due to a

signal failure.

The mouse/keyboard/monitor shall have extra length of cable depending on the location of CPU rack (normally placed behind LVS panel).

Individual Monitors shall be supplied for all stations (except LVS OWS) Bidder to ensure that the aspect ratio of these monitors is same as that of the LVS being supplied.

3.49.04

Specification for Lap-Top (Note-Book) PC

All the Laptop will also be used as pluggable temporary programmer's station and operator station functionalities of the programming stations mentioned in the specifications shall be provided (including requisite license).

The LapTop shall meet following minimum requirements:

- Intel Centrino™ Mobile Technology.
- Intel Core – i7 Processor with 3.46 GHz, 4 MB L2 cache, 1066MHz
- FSB.
- 15" WXGA LED Screen with wide angle viewing.
- 1000 GB 7200 rpm HDD with shock absorber.
- 4 GB 800 MHz DDR3 SDRAM (slot for 1no. additional RAM slot should be provided)
- 1024 MB Graphic Accelerator
- 1 x windows XP/7 Professional or latest & proven version of Windows OS with Multimedia
- Slim type DVD-RW/DVD ROM combo drive.
- Internal 10/100/1000Mbps Ethernet card
- IEEE 802.11B connectivity port
- IR port
- Optical mouse
- 2Nos. USB 3.0/2.0 ports & Wireless INTERNET & blue tooth interface
- External mouse connectivity and optical mouse
- Minimum 8 hrs battery backup.
- Recovery software tools.
- Sound cards
- Internal speakers
- General MS Windows latest, MS-Office Professional, Microsoft Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.
- Application engineering & HMI software - to suit project specific requirement.
- Carry Bag.

3.49.05

Large Video Screen (LVS)

Large video screens, complete with projectors, screens, control units (graphical generators), Master controller, Matrix switcher & associated accessories shall be supplied as per the following specifications.

1. Size (diagonal) 65 inch – 70 inch
2. Type LED illuminated Digital Light Processing (DLP) technology with rear projection configuration.
3. Resolution of each screen Minimum 1400 x 1050 pixels and should offer 16.7 million colors.
(Bidder to ensure that the aspect

6.06.00 Unit-Incharge Desk

Profile and construction of the Unit Incharge Desk shall be same as that of CD. Provision for Operator Work Station and PA system/ telephone handset etc. shall be provided similar to the Control Desk..

6.07.00 Internal Panel/Desk Items

6.07.01 Equipment and devices mounted within the panels/desk shall be mounted on suitable racks/brackets and shall be arranged for convenient access for adjustment and maintenance work.

6.08.00 Furniture

6.08.01 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. Each module shall have transparent cover and adjustable partition. It shall have locking provision for security. The components shall be suitable for integration/fabrication without any welding technology.

a. Work Station furniture

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (inkjet or A4 laser) etc. is to be provided.

b. Server Rack

Server rack shall be provided to mount programmer stations, PC based systems (of rack type and tower type), Matrix KVM switcher, Mini UPS etc. in Programmer room. Suitable arrangement for Ventillation and cooling shall be built in.

c. OWS/PC rack

OWS/PC rack shall be provided to mount CPUs of work stations/PCs of OWS/LVS etc in Control Room.

d. 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, shift in charge & other personnel in control room area & BOP's control rooms, Chief Engineer room and all other executive rooms, simulator rooms, Conference room, DMS room, SWAS room, CEMS room, meeting room, documentation room, staff room, CAAQMS shelters, CAAQMS rooms etc. These shall be designed for sitting for long duration such that these are comfortable for the back. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and

twin wheel castor of glass filled nylon. The exact details shall be finalised & approved by Purchaser during detailed engg.

e. Tables

- a. Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering.
- b. Conference Room standard tables shall be made of teak wood top quality only with industry standard glass top and provided with acrylic coat for good finish. Details shall be finalised & approved by Owner during detailed engg.
- c. Glass top teak wood office table with lockable drawers shall be provided for shift in Charge room, Chief Engineer room and all other executive rooms.

f. Almirahs

Minimum 4 nos. vertical Steel Almirahs shall be provided for keeping documents in the documentation room. Vertical Steel Almirahs shall also be provided for the following rooms.

- a. Conference room – Two (2) nos. min.
- b. PADO Room – One (1) no. min.
- c. Shift In charge room – One (1) no. min
- d. Simulator Room – Two (2) nos. min.
- e. BOP/Offsite package control room – Two (2) nos. min.
- f. Head of Station Room- Two (2) nos. min

Final quantity shall be decided by owner during detailed engineering

Thickness of steel almirah sheet shall be 18 gauges with neat finish. Tentative size of Almirah shall be 78"(H) x 36"(W) x 19"(D). 4-5 mm thick Glass doors for each rack shall be provided such that the documents are visible from outside. Minimum 5 no. horizontal partition/rack shall be provided in the almirah. 3 point locking system shall be provided. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by owner during detailed engg. One uniform colour shall be finalized during detailed engineering by owner.

g. Keypad

Keypads shall be provided for the storing of keys of relevant areas in the respective control rooms

h. Lockers

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel & also for documents.

6.09.00 LVS PANEL



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 26.02.18
			SHEET 1	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	1 x 6600 MW PANKI Thermal Power Project		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to 70 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR REGULATING SERVICE - 150 STARTS/HR MINIMUM OR REQUIRED CYCLES WHICHEVER IS HIGHER..		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☒ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☒ RAL 7032		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☒ 110 V		



SPECIFICATION FOR MOTORISED VALVE ACTUATOR

SPECIFICATION NO.:

VOLUME II B

SECTION D

REV. NO. 00

DATE: 26.02.18

SHEET 2

OF 4

Data Sheet A & B

DATA SHEET-A
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY BIDDER)

	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ FLAME PROOF		
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B		
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos., 1 IN EACH PHASE) ☐ -----		
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED		
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED		
	TYPE OF SWITCHING DEVICE	☒ CONTACTORS(Reversing type) ☐ THYRISTORS		
	TYPE	☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)		
	IF SMART			
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED		
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐		
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC		
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED		
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐		
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED		
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP		
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED		
	STEP DOWN CONT. TRANSFORMER	☒ REQUIRED		
	OPEN-STOP-CLOSE PB(running open/close LED) THREE POSITION SELECTOR SWITCH	☒ REQUIRED ☐ NOT REQUIRED		
	INDICATING LAMPS	☒ REQUIRED ☐ NOT REQUIRED		
	LOCAL-OFF- REMOTE S/S(THREE POSITION SELECTOR SWITCH)	☒ REQUIRED ☐ NOT REQUIRED		
	STATUS CONTACTS FOR MONITORING	☒ REQUIRED ☐ NOT REQUIRED		
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIP/O/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD.)		
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☒ OPTO COUPLER ☐ EITHER		
	QUANTITY	☒ 2 NOs. ☐ 3 NOs.		
	DRIVING VOLTAGE	☒ 20.5 – 24V DC ☐ _____ V DC		
	DRIVING CURRENT	☒ 125mA MAX ☐ _____ mA MAX		
	LOAD RESISTANCE	☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms		
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN / CLOSE	☐ 1 No. ☒ 2Nos. / ☐ 1 No. ☒ 2Nos		
	CONTACT TYPE	2 NO + 2 NC		
	RATING	5A 250V AC AND 0.5A 220V DC		
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE		
	ACCURACY	+3% OF SET VALUE		
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN : INT : CLOSE	☒ 2 Nos. 2 nos(adj) 1 No.	☒ 2Nos.	
	CONTACT TYPE	2 NO + 2 NC		
	RATING (AC / DC)	5A 250V AC AND 0.5A 220V DC		

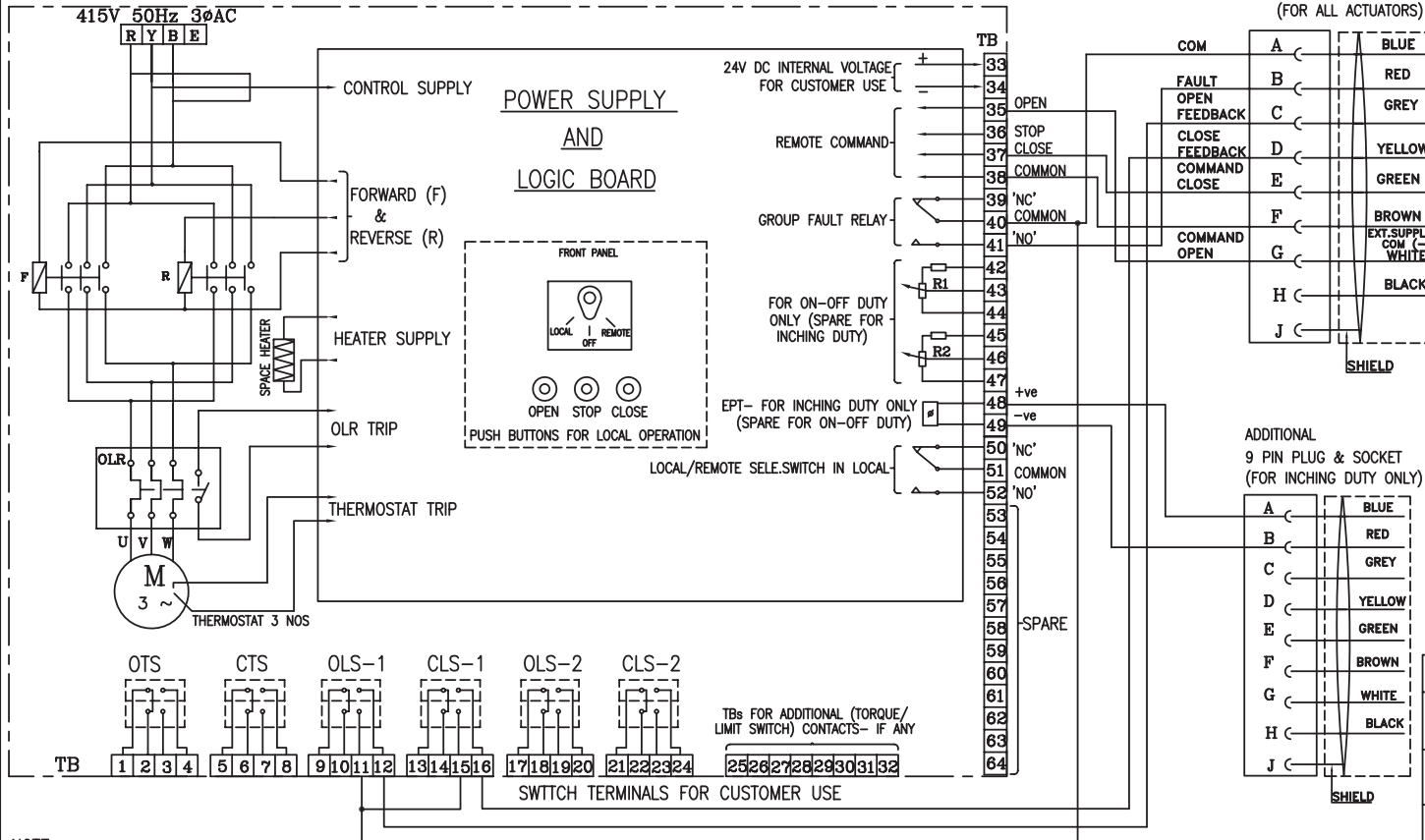
	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:		
		VOLUME	II B	
		SECTION	D	
		REV. NO.	00	DATE: 26.02.18
		SHEET	3	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	REQUIRED for regulating/inching duty only.	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) contactless inductive type	
	SUPPLY	☒ 24V DC ☐	
	OUTPUT	☒ 4-20mA	
	ACCURACY	$\pm 1\%$ FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC, 1 PH., 50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☒ IP 68 @ ☐ NEMA6	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET (9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☒ REQUIRED ☐ NOT REQUIRED ☒ 2 NOS. ☐	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----	
	@ SPACE HEATER CABLE GLAND	SIZE:-----	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP (Cable size 2Px1.5mm ²)	
	OTHER CONTROL CABLE GLANDS-2	1 no suitable for 8P X 0.5 sq mm Additional 1 no suitable for 2P X 0.5 sq mm (inching duty only)	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 26.02.18
			SHEET 4	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.	
NOTES: SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 - TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. - CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED. - 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. - THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY. -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. - THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS. - IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR. - POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL - WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM. - THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE AND RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH. - THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE. - ALL SIX (6) LIMIT SWITCHES SHALL BE CHANGEOVER TYPE AND ADJUSTABLE BESIDES HAVING THE SNAP FACILITY. - THE INTEGRAL STARTER WHICH SHALL HAVE SOPHISTICATED ELECTRONIC CONTROLS WITH FIELD PROGRAMMING FEATURE. IT SHALL BE DESIGNED FOR REMOTE CONTROL FROM DCS/RESPECTIVE CONTROL SYSTEM. REQUIRED INTERPOSING RELAYS FOR RECEIVING OPEN/CLOSE/STOP COMMAND FROM DCS/RESPECTIVE CONTROL SYSTEM SHALL BE PROVIDED. POTENTIAL FREE CONTACTS AND TRANSDUCERS SHALL BE PROVIDED TO PROVIDE STATUS INDICATION AT REMOTE DCS/RESPECTIVE CONTROL SYSTEM. - THE REMOTE COMMAND SIGNAL (OPEN-STOP-CLOSE) FROM DCS/RESPECTIVE CONTROL SYSTEM/CONTROL PANEL SHALL BE ISOLATED FROM CONTROL ELECTRONICS THROUGH OPTO-ISOLATOR. - THE FOLLOWING INDIVIDUAL STATUS ANNUNCIATION LED'S (COLOUR-GREEN) SHALL BE PROVIDED LOCALLY (INTEGRAL TO ACTUATOR) TO ANNUNCIATE THE FOLLOWING FOR EASY LOCAL MONITORING. ACTUATOR IN LOCAL MODE ACTUATOR IN REMOTE MODE ACTUATOR RUNNING IN OPEN DIRECTION ACTUATOR RUNNING IN CLOSE DIRECTION ACTUATOR IN INCHING MODE. ACTUATOR IN SELF-RETAINING MODE LIMIT SWITCH OPEN TRIP LIMIT SWITCH CLOSE TRIP CONTROL VOLTAGE AVAILABILITY				
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ELECTRICAL				

3-V-MISC-24283

DRAWING NO.



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	
SWITCH	TERMINAL NO.	VALVE POSITION
	FULL OPEN	INTERMEDIATE
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:-

- 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
- OTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER (CONTACTLESS TYPE, FOR INCHING DUTY)
- R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3φ 415V 50 Hz AC SUPPLY
- TORQUE SWITCH BYPASS WITH LIMITSWITCH BOTH ON OPEN & CLOSE DIRECTION TO BE DONE INTERNALLY.

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT		ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS FOR NTPC PROJECTS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)				
DEPT	VL	SCALE	WEIGHT (KG.)	REFERENCE INFORMATION	NO. OF ITEMS	
CODE	-	NTS	-		-	
TITLE WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET FOR NTPC PROJECTS				CARD CODE U 01	REV 0	
BHARAT HEAVY ELECTRICALS LTD., UNIT: HIGH PRESSURE BOILER PLANT. TIRUCHIRAPALLI-620014.		DRN CHD APPD	NAME N.P.ESWAR D.DINAKARAN K.ARUNACHALAM	SIGN N.P. D.D K.A	DATE 17.03.05 17.03.05 17.03.05	

CHAPTER –11: CONTROL VALVES WITH ACTUATORS

11.01.00 CONTROL VALVES, ACTUATORS & ACCESSORIES

11.01.00 General Requirements

- 11.01.01 The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Sub-section will be fully suitable and compatible with the modulating loops covered under the Specification.
- 11.01.02 All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.
- 11.01.03 For special type of control valves such as combined pressure and temperature control valves for Aux PRDS application, separator drain control valves, also refer to the corresponding mechanical sections.

Control valve station shall be provided at the interconnection line between service air header and instrument air header before air dryer unit. When instrument air header pressure falls below set value, the control valve will start opening and maintain the instrument header pressure at specified level in line with plant requirement. Again when instrument air header pressure goes above specified level in line with plant requirement the control valve will fully close automatically. Complete system shall be in bidder scope.

11.02.00 CONTROL VALVE SIZING & CONSTRUCTION

- 11.02.01 The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
- 11.02.02 The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA handbook on control valves. While deciding the size of valves, Bidder shall ensure that valves trim exit outlet velocity as defined in ISA handbook does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which will be subject to Owner's approval during detailed engineering.
- 11.02.03 Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti cavitations trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.

- 11.02.04 Control valves for application such as Feed water control valve, HP & LP by pass spray control valves, APRDS control valves, Soot blower control valve, separator drain control valve, SH Spray Control, RH spray Control, Heavy Oil Heating, pressurizing and Control system, HP/LP heater Emergency level control, Emergency Make-up to condenser hotwell, GSC minimum flow, Deaerator Drain to Condenser Hotwell, Condensate spill to condensate reserve tank, condenser normal make- up and valve gland sealing supplying pressure control, CEPs minimum flow control, BFP minimum circulation control valve shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV.
- 11.02.05 The control valve induced noise shall be limited to 85 dba at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.
- 11.02.06 The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services.
- 11.02.07 The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.
- 11.02.08 The valve travel time shall be less than 10 second for non critical services valves.
- 11.02.09 Rangeability should be 50 to 1 (min.) for non critical services valves.
- 11.02.10 Modulating Type Control Valve's Linearity, Hysteresis, Accuracy shall be < +1% and Sensitivity shall be < + 0.5%.
- 11.03.00 VALVE CONSTRUCTION**
- 11.03.01 All valves shall be of globe body design & straightaway pattern with single or double port, unless other wise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.
- 11.03.02 Valves with high lift cage guided plugs & quick-change trims shall be supplied.
- 11.03.03 Cast Iron valves are not acceptable.
- 11.03.04 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.
- 11.03.05 Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.
- 11.03.06 All valves connected to vacuum on down stream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing)
- 11.03.07 Valve characteristic shall match with the process characteristics.
- 11.03.08 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.
- 11.03.09 Flanged valves shall be rated at no less than ANSI press class of 300 lbs.

11.04.00 VALVE MATERIALS

Sr.No.	Service	Body material	Trim Material
1	Non-corrosive, non-flashing, and non-cavitation service except DM water	Carbon steel ASTM-A216 Gr WCB for fluid temperature below 275 Deg. C Alloy steel ASTM-A217Gr. WC9 for fluid temperature above 275 Deg. C	316SS stellited with faced guide posts and bushings.
2	Severe flashing/cavitation services	Alloy steel ASTM-A217 Gr. WC9	440 C
3	Low flashing/cavitation services	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS
4	DM water services	SS 316	316 SS

NOTE Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-a-vis the specified material for Owner's consideration and approval.

11.05.00 END PREPARATION

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Owner's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of the control valve body.

11.06.00 VALVE ACTUATORS

All control valves shall be furnished with pneumatic actuators except for pressure and temperature control valve for auxiliary PRDS application (Electro-hydraulic / pneumatically operated) and HP & LP bypass valves, separator drain control valve (Electro-hydraulic type). The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg.C continuously.

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 Kg/sq.cm. per linear millimeter of seating surface, shall be provided in the

selection of the actuator to ensure tight seating unless otherwise specified.

The travel time of the pneumatic actuators shall not exceed 10 seconds.

11.07.00 CONTROL VALVE ACCESSORY DEVICES

11.07.01 All pneumatic actuated control valve accessories such as air locks, hand wheels/hand-jacks, limit switches, microprocessor based electronic Positioner, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements.

11.08.00 SPECIFICATIONS FOR MICROPROCESSOR BASED ELECTRONIC POSITIONER

1	Electrical	a) Input Demand Signal	4-20 mA
		b) Power Supply	Loop Powered from the output card of Control System.
		c) HART Protocol	Compatibility for Remote Calibration & Diagnostics (Super-imposed HART signal on input Signal (4-20 mA)
		d. Valve position sensing	Position sensing, 4-20 mA output signal to be provided for control system.
2	Environment	a) Operating temp.	(-)30 To 80 Deg. C
		b) Humidity	0-95 %
		c) Protection class	IP-65 Minimum with Die cast Aluminum/SS316 enclosure.
3	Software for Configuration and Diagnostics	Software	Windows based software. Software shall meet the requirements for Configuration, Diagnostics, Calibration and Testing of the actuator.
		Diagnostic/Test features	Advanced diagnostic features like Stroke counter or Travel counter, Leakage in actuators, Valve Signature analysis, Step Response test, Valve friction /Jamming detection etc. to be provided.

4	Test reports/ Certificates	Factory Valve Signature Tests Reports (Pressure versus Valve travel and Travel versus I/P signal) are to be provided.	
		Test certificates as per Manufacture Standard/Relevant Standard are to be submitted.	
5	Configurat ion/ Calibration	Remote & Local Calibration, Auto & Manual Calibration shall be possible.	
6	Operating Range	Full range/ Split range.	
7	Modes	Valve Action	Direct / Reverse Valve Action
		Flow Characterization	Possible to fit Valve Characteristic Curves- Linear , Equal percentage etc.
8	Fail Safe/Fail Freeze	Fail Safe/Fail Freeze feature is to be provided. (In case the fail freeze feature is not intrinsic to the positioner, Bidder shall achieve the same externally through solenoid valve connected in the pneumatic circuit).	
9	Pneumatic	Air capacity	Sufficient to handle the valves & actuators selected/ Boosters to be supplied, if required.
		Air pressure	To suit the air supply pressure/quality available.
		Process connection	1/4" NPT
10	Performance	Characteristic deviation	≤ 0.5 % of span.
		Ambient temp effect	≤ 0.01 %/ deg C or better.
11	EMC & CE compliance	Required to International Standard like EN/IEC.	EN50081-2 & EN 50082 or equivalent.

12	Accessories	In-built Operator Panel	Display with push buttons for configuration and display on the positioner itself (Password protected/Hardware lock).
		Hand Held Hart Calibrator	Universal Hart Calibrator to be provided (for quantity, refer Part-A Vol-V C&I :).
		Pressure Gauge Block & Position Indicators.	For supply & output pressures, Air Filter Regulator, integral type position transmitter, in built mechanical position indicator and other accessories shall be provided on as required basis for making system complete.
		Electrical Cable Entry	1/2" NPT, side or bottom entry to avoid water ingress.
		Valves Mounting Assembly	For Sliding Stem/Rotary/Single acting/Double acting actuators on as required basis.

*** Note:**

The HART signals shall be picked up from marshalling terminals of DDCMIS (SG/TG DDCMIS as well as BOP DDCMIS), as applicable. The details of the above mentioned HART management system specification are mentioned in HART system Vol-V, Part B, Chapter 3, DDCMIS, cl. no. 3.45.00

The positioners shall be monitored from this HART management system .To achieve this, Bidder shall provide the necessary software to achieve the functionalities described above under "Remote Configuration and Diagnostics", and this software shall be loaded in the HART management system.

11.09.00 FOR FOLLOWING CRITICAL APPLICATION SPECIAL CONTROL VALVES ARE REQUIRED:

1. HP & LP Bypass Valves and Control System
2. BFP – Minimum Re-circulation Valve
3. Feed Water Control Valve
4. SH & RH spray Control Valves
5. APRDS System
6. Soot Blower control valve
7. Separator Drain Control Valve.
8. Fuel oil heating and pressurizing
9. Minimum economizer flow control
10. DM make up (emergency / normal)

11. Control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control.
12. CEP minimum flow control

11.09.01 General Requirements for Critical Application Control Valves -

- i) The valve accessories shall include hand wheels, limit switches, smart valve positioner (4-20mA DC type), electro pneumatic converter, Air lock relay, Solenoid valve and all other items required for the completeness and the accessories shall be explosion proof type as per hazardous area classification wherever applicable.
- ii) Control valves shall be furnished with IBR certification wherever required.

1. **Noise:** The maximum allowable noise level shall be 85 dba or less at 1 m. distance from the downstream bare pipe surface. The specified noise level shall be attained without the use of orifices, mufflers, diffusers. No credit for thermal or acoustical insulations shall be taken.

2. **Valve Trim:** Valve shall have quick change type trim utilizing top entry. No components shall be screwed or welded into the body. The valve shall have equal pressure distribution around the plug to avoid chattering / vibration.

Trim of severe/critical service valve shall be of multi stage & multi path design with sufficient no. of discrete pressure drop stage to eliminate the chance of erosion, cavitations, noise, vibration through out the control range of valve.

3. **Leakage Class:** The valve shall have minimum class-V leakage for all steam applications including RH/SH, APRDS, Soot Blower control valve, HP/LP Bypass spray control valves, BFP minimum recirculation valve & Low Load feed water control valve.

In case of HP/LP Bypass control valve application, the leakage class should be MSS-SP 61 (block valve leakage).

4. **Actuator:** Actuator type should be pneumatic double acting piston/electro-Hydraulic.

11.10.00 TEST AND EXAMINATION

All valves shall be tested in accordance with the quality assurance program agreed between the Owner and Contractor, which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. The tests shall include but not be limited to the following:

- 11.10.01 Non Destructive Test as per ANSI B-16.34.
- 11.10.02 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.
- 11.10.03 Valve closure test and seat leakage test in accordance with ANSI-B 16.34 and as per the leakage class indicated above.
- 11.10.04 Functional Test: The fully assembled valves including actuators control devices

and accessories shall be functionally tested to demonstrate times from open to close position.

11.10.05 CV Test: Please refer CI No. 13.00.00, Vol. V Part-B, Chapter : 13 (Type test requirements), Control Valves.

Bidder shall furnish all the control valves under this main plant package as finalized during detailed engineering stage without any price repercussions whatsoever depending on the process requirements. All the control valves provided by the Bidder for this project shall meet the specifications requirements specified herein. Specification for control valves in this chapter has to be read in conjunction with other relevant chapter of this specification.



Technical specification
for
1X660 MW TPS PANKI EXTN.

REV. NO. 00 DATE : 04.04.2019

PROCESS CONNECTION & PIPING

Chapter 8 PROCESS CONNECTION AND PIPING

8.00.00 PROCESS CONNECTION PIPING

8.01.00 The Bidder shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this chapter, enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipments (provided by the bidder) to the process on as required basis for the connection of all instruments and control equipments of entire plant.

The installation and source connection of various items shall generally as per NIT installation drawings (Drawing No. 14A14-DWG-I-0010), however, the bidder shall furnish during detailed Engineering. Installation drawings, GA and fabrication drawings of LIES/LIRs, other relevant drawings, material and tech data sheets of various items service wise for owner's approval/information.

8.01.01 All material, furnished under this chapter and the installation there of shall conform to the latest editions of American National standard Code for pressure piping, power piping ANSI B 31.1, ANSI B16.11, ASME Boiler and pressure Vessel codes, IBR and other applicable ASME, ANSI and state standards.

8.01.02 All material supplied under this chapter shall be suitable for intended service, process, operating conditions and type of instructions used and shall fully conform to the requirements of this specification. The bidder is responsible for the performance of equipments furnished under this specification on system basis. The bidder may offer suggestions for improvement based on his experience, during detailed engineering, which shall be subjected to the Owner's approval.

8.01.01 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

8.01.02 All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The size of impulse pipe shall be 1/2" for steam and water applications and 3/4" for air and flue gas applications. The material of impulse pipe shall be same as that of main process pipe. For various applications specification of impulse pipe materials and associated fittings and valves shall be as given in table PCP..

8.01.03 SS tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping class A, B, C & D of the table no PCP) the material shall be ASTM A 213 TP 316H it and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D.

8.01.04 All fittings shall be forged steel and shall conform to ANSI B16.11. The material of forged tube fittings for shaped application (e.g. tee, elbow etc) shall be ASTM A 182 Gr 316 H for high pressure/temperature applications (as defined above) and ASTM A 182 Gr 316 L for other applications. The material for bar stock tube fitting (for straight application) shall be SS 316. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with they are to be used.



The source shut off (primary process root valve) and blow down shall be ½ inch size globe valve type for all applications except for air and flue gas service wherein no source shut off valves are to be provided. For various applications the valve body material, stem material and pressure class shall be as given in table 8.1. The end connections of valves shall be of socket welded type unless otherwise specified in the instrument installation diagrams. The disc and seat ring material of carbon Steel and alloy steel valves be ASTM-A-105 and ASTM-A-182 Gr F22, hard faced with satellite (minimum hardness-350 BHN). The surface finish of 16 RMS or grater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

For Pr/D.P. gauges in fluid application two way globe valve on each impulse line to the instrument and in air/flue gas application two way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the Pressure/Differential pressure gauges.

The rating of material of impulse pipes, tubes, fittings, valves and their installation thereof shall conform to the latest edition of standards as per following table:

Impulse Pipe, Tube (material & rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material Pr. Class, size)	ASTM A 182/ ASTM A 105 as per ASME 16.34
Fitting (Size, rating, material)	ANSI B31.1, ANSI B31.1a, ASME B16. 11-2009
Installation Scheme	BS 6739-2009, ANSI/ISA 77.70

Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided. Two root valves are to be used wherever pressure is more than 40 Kg/cm² or Temp>280 deg C. The end connections of valves shall be of socket welded type.

8.01.03 The valve manifolds of 316 SS with pressure rating suitable for intended application shall be provided as given below:

Manifold	Application/Measurement
2 Valve	Pressure measurements using pressure transmitters/pressure switches.
3 Valve	Pressure measurements using differential pressure transmitter/switches.
5 Valve	Differential Pressure, Flow and Level Measurements

For Pr./D.P gauges, two-way globe/gate valve shall be provided on each impulse line to the instrument in Fluid/Air & Flue Gas applications respectively .

- 8.01.04 Double ferruled compression type fittings shall be used only, wherever required.
- 8.02.00 **AIR SUPPLY PIPING**
- 8.02.01 All pneumatic piping, fittings, valves, air filter cum regulator, purge rotameter and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided. This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements etc.
- 8.02.02 Instrument air and Service air supply shall be provided for continuous and intermittent purging respectively for all transmitters of mill, dirty air and flue gas applications. Purging scheme shall be as per drawing no. 14A14-DWG-I-0010.
- 8.02.03 The Bidder shall also provide and connect pneumatic tubing to E/P convertors and then to control valves. For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered PVC coated copper/SS tubing conforming to ASTM B75 shall be used. It shall be at least 0.065 inch. The fittings to be used with copper/SS tubes shall be of cast brass/SS, screwed type. All other air supply lines shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. Fittings for air supply line shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs. Air supply piping shall be adequately sloped to prevent accumulation of condensed water within the pipe. The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports.
- 8.02.04 The instrument/service air supply to each equipment/devices requiring air supply shall be provided by a well designed air distribution scheme comprising of 2" GI Pipe Header with isolation valve from the instrument air and service air terminal points. In the boiler/turbine area the 2 inch head shall be provided upto most elevation of boiler/turbine floor and from this 2 inch header, 1 inch sub header shall be branched off at each floor with isolation valve. From this 1 inch sub-header, branch line of ½ inch, with isolation valve shall be provided upto various devices. Similar system is to be followed for service air required for intermittent purging in the local instrument enclosures (LIEs) Instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply except for Ash Handling System wherein it shall be provided on instrument air header at each location. The filter regulators shall be suitable for 10 kg/cm² max. Inlet pressure. The filter size shall be 5 microns and of material sintered bronze. The air set shall have 2 inch size pressure gauge and built in filter housing blow down valve. The end connection shall be ¼ inch/1/2 inch / 3/4 inch NPT as per the requirement to be finalised during detailed engineering.
- 8.02.05 All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.

8.02.06 Purge Air Connection for Air & Flue Gas applications

The continuous purging with instrument air shall be done, for all air and flue gas measurements, at the process source connection end. Necessary arrangements required for continuous purging shall be provided inside all instruments enclosures and instrument racks for Aot and flue gas applications.

For intermittent purging with service air, necessary arrangements inside all the air and flue gas enclosures shall be provided. The SS316 four ways valve provided in the SS316 tubing shall be used for isolating the transmitter and connecting the service air quick disconnect line.

Purging arrangement is not required for instrument air and service air measurement applications. Purge air lines shall be of mild steel hot dipped galvanised inside and outside as per IS1239, heavy duty with threaded ends.

8.03.00 Process Connections

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.

Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 425°C
(ii)	1	15NB	< 40 bar (g) AND 425°C .
Level Measurement			
(a) Level Gauge & Switch			
(i)	2	25NB	≥ 40 bar(g) OR 425°C
(ii)	1	25NB	< 40 bar(g) AND 425°C
(b) Level transmitter (displacement type)			
(i)	2	40NB	≥ 40 bar(g) OR 425°C
(ii)	1	40NB	< 40 bar(g) AND 425°C
(c) Stand pipe for level measuring instrument			
(i)	2	80 NB	≥ 40 bar(g) OR 425°C
(ii)	1	80 NB	< 40 bar(g) AND 425°C
Flow Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 425°C
(ii)	1	25NB	< 40 bar(g) AND 425°C
<u>Sampling system measurement (Steam and Water Service)</u>			
(i)	2	25 NB	≥ 40 bar(g) OR 425°C
(ii)	1	25 NB	< 40 bar(g) AND 425°C

8.04.00 **INSTALLATION AND ROUTING**

8.04.01 All instrument piping, tubing and its accessories shall be supported in a safe



manner to prevent excessive vibrations and anchored sufficiently to prevent undue strain on connected equipment.

Instrument piping & tubing shall not be routed across equipment removal areas, above or below monorails, cranes, removable gratings, cable trays.

For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instruments shall be installed above source point and impulse pipe should slope upwards.

Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent and drain lines along with isolation valves and other accessories including drain pipes this drain is to be connected to plant drain through open funnel also. Horizontal must have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope and to prevent sag in piping.

All impulse piping shall be installed to permit free movement due to thermal expansion, wherein required expansion loops shall be provided.

Special accessories such as condensing pots/reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services and all flow measurements in steam and water services above 120 Deg. C. For drum level measurement required balancing chamber shall be provided and installed.

Colour coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.

Instrument Air & Service Air piping/tubing system

The air supply headers, sub headers and branch pipes shall be supported properly by clamps or supports to be provided and fabricated by the bidder. Air supply piping shall be installed with a slope of over 1/100 to prevent accumulation of condensed water within the pipe. Signal/control air tubing shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy link up and checking of proper connections. Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkups and for connections.

PIPING /TUBING SUPPORT

Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports.

Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant

metals and hot-dip galvanised.

8.05.00 **SHOP AND SITE TESTS**

8.05.01 The equipment and work performed as per this chapter shall be subject to shop and site test as per requirements of Vol. II & Vol. V (Quality Assurance & Inspection) other applicable clauses of this chapter and Owner approved quality assurance plan.

8.05.02 Hydrostatic and Pneumatic leakage tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.

8.05.03 Hydrostatic testing

All instrument piping/tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.

Air testing

All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 Kg/sq.cm through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.

8.06.00 **LOCAL INSTRUMENT ENCLOSURE AND RACKS**

All transmitters, switches etc. in Boiler Turbine Generator measurements (except for all fuel oil applications) shall be suitably grouped together and mounted inside (i) Local instruments enclosures in case of open areas of the plant like boiler area, etc. and (ii) In local instrument racks in case of covered areas like Turbine/Generator area.

These local instrument enclosures and racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalised during detailed Engineering stage subject to owner's approval. The GA of LIR should be similar to LIE except for front/rear doors and side panels. Vol. V, Part B, Chapter no. 6 shall also be referred for designing of LIE & LIR.

Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

The internal layout shall be such that the impulse piping/ blow down lines are accessible from back side of the enclosure / rack and the transmitters etc. are accessible from front side for easy maintenance. Bulkheads, especially designed



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



to provide isolation from process line vibration shall be installed on instrument enclosures/racks to meet the process sensing line connection requirement.

Vibration dampeners shall be installed for each enclosure / rack. The Degree of Protection of LIE shall be IP-55.

The enclosure shall be constructed of 1.6 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Cable glands, Channel and frame shall be 3 mm thick. Double inter locking doors shall be provided. The doors shall be the three point locking type constructed of not less than 1.6 mm thick steel. Doors shall have concealed quick removal type pinned hinges and locking handles. Door locks shall accept the same key.

Neoprene/Polyurethane Gaskets shall be used between all mating sections to achieve protection class of IP-55.

The instrument racks shall be free standing type constructed of suitable 3 mm thick channel frame of steel and shall be provided with a canopy to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel, and extended beyond the ends of the rack.

Bulk heads, especially designed to provide isolation from the process line vibration shall be provided. Exact fabrications details shall be as finalised during detailed Engineering stage. The junction box for LIE/LIR shall conform to IP -65 protection class.

Enclosures/Racks shall be reinforced as required to ensure true surface and to provide adequate support for instruments and equipment mounted therein. Centre posts or any member which would reduce access shall not be provided.

Each Transmitter enclosure housing instruments requiring purge air for continuous air purging, shall be provided with common purge air header, redundant air filters regulators of sufficient capacity , required pressure gauge, valves, fittings, SS tubing and individual purge meters for each purge line etc as required and indicated in instrument installation drawings enclosed herewith.

A 15 mm NB service air header shall be furnished in each instrument enclosure housing air and flue gas and coal mill instruments. The header shall be furnished complete with a pressure regulating valve, pressure gauge and quick disconnect connections. A hose for connecting each header to the draft instrument line four way valves shall be furnished. The hose shall be self storing nylon tubing having a burst pressure of 15 Kg/sq Cm the size of the hose shall be ½ " min. The service air header shall originate at a bulkhead penetration or fitting located on one of the bulkhead plates.

The bidder shall prepare the piping drawings and the general arrangement layout drawings for each of the enclosures and racks. The special attention shall be given in the piping layout to avoid air traps liquid filled piping or water pockets in piping intended to be dry. Drawings shall indicate the arrangement of all equipment, piping, valves and fittings within the enclosures/racks and shall be subject to owner's approval.



All liquid Filled Blow down lines, except those measuring vacuum shall be connected to a two inch header which is extended through one end of the enclosure and turned downward for directing the blow down into a drain. The material of the blow down header shall be carbon steel as per ASTM A 106 Gr C or as indicated in NIT's hookup drawings whichever is better.

The bidder shall submit to the owner with his proposal a copy of his welding procedure specification together with proof of his compliance with the latest applicable welding ANSI code. Prior to any welding being performed the bidder shall submit the qualifications of the craftsmen who will perform the work.

Bidder shall provide not more than three variants for LIE/LIR with respect to max. no. transmitters mounted in each LIE/LIR.

Each enclosure shall be provided with universal type 6/16 Amp. power receptacle, light fixture & LED lamps with wire guard and lighting switch etc. Lighting switches shall be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and power receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

Power Supplies for miscellaneous devices shall be provided with 2P MCB located within the enclosures. MCB shall be mounted in Fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.



1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



Technical Specifications for C&I Systems-Table-No. 8.1

S. No.	System/Line Description	Piping Class	Impulse Pipe material	Schedule (Size)	Materials for fitting/ valve body	Valve stem material	Rating of Piping Fitting	Pressure Class of valve
1	Main steam, Up stream & down stream of HP bypass and up stream of auxiliary steam pressure reducing valve, separator level.	A	ASTM-A335 Gr.P-91/22 (Note-2)	XXS (½ Inch)	Note-3	Note-3	9000lb	3000 SPL
2	BFP discharge/ superheater attemperator/spray to PRDS, Phosphate dosing, P/P discharge, BCW pumps.	B	ASTM-A106 Gr. C	160 (½ Inch)	Note-3	ASTM-A-182 Gr.F6a	6000lb	2500 SPL
3	Reheater attemperator	C	ASTM-A106 Gr. C	160 (½ Inch)	ASTM-A-105	ASTM-A-182 Gr.F6a	6000lb	1500 SPL
4	Hot. Reheat/Down stream of Aux.Steam pressure reducing valve upto desuperheater/flash tank drain manifold, HRH upstream & down stream of LP Bypass valve, HP heater level.	D	ASTM-A335 Gr.P-91/22 (Note-2)	160 (½ Inch)	ASTM-A182 Gr.F-22	Note-3	3000lb	2500 SPL
5	Cold reheat upto Tee-off for HP bypass.	E	ASTM-A335 Gr.P-22	80 (½ Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
6	Cold reheat down stream of Tee-off (HP Bypass)	F	ASTM-A106 Gr. C	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
7	BFP suction/condensate	G	ASTM-A106 Gr. C,	80 (½ Inch)	ASTM-A105	ASTM-A-182	3000lb	800

	system/Extraction to LPH/HPH and Extractions to BFPT, Deaerator, auxiliary steam, service air, instrument air, DMCW/ECW pumps, and other low pressure water services.		ASTM-A335 Gr.P-11/22			Gr.F6a		
8	Air/Flue gas outside furnace, coal-air mixture.	M	ASTM-A106 Gr.C	80 (3/4 Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
9	Air flue gas inside furnace	N	ASTM-A335 Gr.P-22	80 (3/4 Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
10.	Purge Air	O	ASTM-A106 Gr.C	80 (3/4 Inch)	ASTM-A105	SS316	3000lb	800
11.	DM Cooling water	P	ASTM-A312 TP 316	80/40 (1/2 Inch)	ASTM – A 182 F 316	SS316	3000lb	800
12.	CW & ACW	Q	ASTM-A106 Gr.C	80 (1/2 Inch)	ASTM-A105	SS316	3000lb	800

Note:-

- 1). Above requirements are minimum to be complied by bidder. Rating of piping / fittings / valves etc. is subjected to be approved by owner as per the final design pressure & temperature finalized during the detailed engineering, as per ANSI B 31.1.
- 2). In case temperature is more than 540 deg C, the material shall be P-91 only.
- 3). Material shall be compatible with that of the impulse pipe material and design parameter.
- 4). For DM Plant or DM water services, complete erection Hardware material shall be SS316 only.
- 5). Separator related impulse piping material shall be as per main process pipe/tank material.

- e) Turbine lube oil pumps
- f) Jacking oil pumps
- g) Emergency turbine trip push buttons in control room.
- h) Boiler turbine: Generator inter-trip which includes the inter connecting cables between:-
- Boiler master fuel trip and turbine trip relays
 - Generator trip relays and turbine trip relays
 - Generator trip relays and 400 kV circuit breaker
 - Generator trip relays and generator field breaker
 - Generator trip relays and UAT breakers
- i) Fire alarm, annunciation and protection system.
- j) Any other system like safety critical circuit, trip protection circuit and for drives required for safe shut down operations of the plant.

9.03.00 INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted group Junction Boxes (JBs) at strategic locations is done and consequently cable with higher numbers of pairs are extensively used between field & Marshalling panels. The details of termination to be followed are mentioned in the given table below:-

Application		Type of Termination	
FROM (A)	TO (B)	END A	END B
Valves/Dampers Drives (Integral Junction Box)	Marshalling/ Marshalling- cum Termination Cubicle/ Local group JB	Plug in connector	Post mount cage clamp type
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction Box of LIE/LIR	Plug in connector	Cage clamp (Rail mount type)
RTD heads	Local Junction Box	Plug in Connector	Cage clamp (Rail mount type)
Thermocouple	Local Junction	Plug in Connector	Cage clamp (Rail

	Box		mount type)
Other Field mounted Instruments	Local JB/ Group JB	Plug in Connector	Cage clamp (Rail mount type)
RTD heads	Temperature transmitter	Plug in Connector	Screwed Cage Clamp Type
Thermocouple	Temperature Transmitter	Plug in Connector	Screwed Cage Clamp Type
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JB.	Group JB	Cage clamp (Rail mount type)	Cage clamp (Rail mount type)
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JB/ MCC/SWGR	Marshalling/ Marshalling – cum Termination Cubicles.	Cage clamp (Rail mount type)	Cage clamp (Post mounted type)
Marshalling cubicle/Termination Cabinets	Electronic system Cabinet	Cage clamp (Post mounted type)	Plug-in connector/other system as per Mfr's standard
Marshalling/ Termination System Cabinets	UCD mounted equipments	Cage clamp (Post mounted type)	Plug in Connector/ Cage clamp Type (rail mounted)
DDCMIS/PLC cabinets	OWS, Printer etc.	Plug in connector	Plug in Connector

Notes

1. For Analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
2. Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands for Explosion proof area, Flame proof area and high vibration prone area.
3. All screwed connections shall be provided with double compression type Nickel-plated brass/SS316 cable glands.

9.04.00 TERMINAL BLOCKS

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

- 9.04.01** All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be rail mounted screw less spring loaded cage clamps type.

The terminal blocks for DDCMIS/DCS/PLC input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for Coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT&VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the bidder and the technical details of the same including width etc. shall be subject to owner's approval.

Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg C and 6.6 polyimide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

- 9.04.02** All the Terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partions, small partions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking etc.

The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams.

- 9.04.03** Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.

- 9.04.04** At least 20 per cent spare unused wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, Junction Boxes, SOV Boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.

All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.

For terminating each process actuated switches, drive actuators, control valves, thermocouples, RTD, etc. in local junction boxes etc. refer NIT's interfacing & wiring drawings.

- 9.04.05** For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to owner's approval without any cost repercussions.

9.05.00 INTERNAL PANELS/ SYSTEM CABINETS WIRING

- 9.05.01 Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.
- 9.05.02 All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferrules at both ends. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.
- 9.05.03 All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.
- 9.05.04 All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.
- 9.05.05 All the special tools as may be required for solder less connections shall be provided by Bidder.
- 9.05.06 Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.
- 9.05.07 Power supply wiring, and interconnecting cables between devices shall pass the following tests.
- Flammability test IEEE 383/1974
 - When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
 - When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
 - Oxygen index not less than 30 as per ASTM D 2863.

9.05.08 Following wire size shall be utilized for internal wiring:

a.	Current (4-20 mA) Low voltage signals (AI/AO & DI signals)	:	0.5 sq.mm
b.	DO signals, Ammeter/ voltmeter circuit, control switches, indicator, recorder	:	0.5 sq.mm
c.	Internal Illumination	:	2.5 sq.mm
d.	Size of Power supply cables shall be as below:-		
	Load		Size
i.	1 to 16 Amp.		- 2.5 sq. mm
ii.	17 to 20 Amp.		- 4 sq. mm
iii.	21 to 32 Amp.		- 6 sq. mm

iv.	33 to 40 Amp.	- 10 sq. mm.
v.	41 to 60 Amp.	- 16 sq. mm

9.06.00 **INSTRUMENTATION CABLE INSTALLATION & ROUTING**

9.06.01 Immediately prior to the installation of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Owner.

9.06.02 Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows:

From 11 kV/6.6 kV/3.3 kV tray system	-	914 mm
From 415V tray system	-	610 mm
From control cable tray system	-	305 mm

9.06.03 Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Double compression cable glands shall be provided.

9.06.04 The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipments/devices shall be in accordance with IEEE-Std-422.

9.07.00 **CABLE LAYING AND ACCESSORIES**

- 1 Cables shall be laid strictly in line with cable schedule.
- 2 Identification tags for cables.

Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.
- 3 Cable tray numbering and marking.

To be provided at every 10m and at each end of cable way & branch connection.
- 4 Joints for less than 250 Meters run of cable shall not be permitted.
- 5 Buried cable protection



Technical specification for
CONTROL & INSTRUMENTATION

1X660MW PANKI TPS EXTN.

SECTION D

REV. NO. 00

DATE : 13.07.2018

INSTRUMENT CHECK LISTS

off, then the cost shall not be payable.

13.01.00 SPECIAL REQUIREMENT FOR SOLID STATE EQUIPMENTS/ SYSTEMS

13.01.01 The minimum type test reports, over and above the requirements of above clause, which are to be submitted for each of the major C&I systems shall be as indicated below:

i) Surge Withstand Capability (SWC) for Solid State Equipments/ Systems

All solid state systems/ equipments shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a power plant. All the solid state systems/ equipments shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Hence, all front end cards which receive external signals like Analog input & output modules, Binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meets the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/ IEEE-472 may also be adopted for SWC test.

ii) Dry Heat test as per IEC-68-2-2 or equivalent.

iii) Damp Heat test as per IEC-68-2-3 or equivalent.

iv) Vibration test as per IEC-68-2-6 or equivalent.

v) Electrostatic discharge tests as per EN 61000-4-2 or equivalent.

vi) Radio frequency immunity test as per EN 61000-4-6 or equivalent.

vii) Electromagnetic Field immunity as per EN 61000-4-3 or equivalent.

Test listed at item no. v, vi, vii, above are applicable for electronic cards only as defined under item (i) above.

13.02.00 TYPE TEST REQUIREMENT FOR C&I SYSTEMS

S.NO Col1	Item Col2	Test Requirement Col3	Standard Col4	Test to be specifically conducted Col5	UPRVUNL's Approval required on Test certificate Col6
1	Elect. Metering instruments	As per Standard (col4)	IS-1248	No	Yes
2	Transducers	As per	IEC-	No	Yes

		Standard (col4)	60688,IS12784		
3	Thermocouple	Degree Protection Test	IS-13947	No	No
4	RTD	As per Standard (col4)	IEC-60751	No	No
5	Electronic Transmitters	As per Standard (col4)	BS-6447/ IEC-60770	No	Yes
6	E/P converter	As per Standard (col4)	Mfr. standard	No	Yes
7	Dust emission monitor	Degree Protection Test	IS-13947	No	Yes
8	Instrumentation Cables Twisted & Shielded*				
	Conductor	Resistance	VDE-0815, IS: 10810	No	Yes
		Diameter test	IS-10810	No	Yes
		Tin Coating test (per sulphate)	IS-8130/84	No	Yes
	Insulation	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Ageing in air ovens**	VDE 0472, IS:5831/1984	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472, IS:5831/1984	No	Yes
		Bleeding and Blooming	IS-10810, IS:5831/1984	No	Yes
		Cold bend test for PVC insulation.	IS:5831/1984		
		Insulation Resistance Test (Volume Resistivity method)	As per GTP		
	Inner sheath***	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Cold bend/cold impact test	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472,	No	Yes

			IS:5831/1984		
	Outer sheath	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Ageing in air ovens**	VDE 0472, IS:5831/1984	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472, IS:5831/1984	No	Yes
		Bleeding and Blooming	IS-10810, IS:5831/1984	No	Yes
		Colour fastness to water	IS-5831/1984	No	Yes
		Cold/bend cold impact test	VDE 0472, IS:5831/1984	No	Yes
		Oxygen index test	ASTMD-2863/77	No	Yes
		Smoke density test	ASTMD-2863, ASTM-D-2843/77	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	fillers				
		Oxygen index test	ASTMD-2863, IEC 60754-1	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	AL-MYLAR shield				
		Continuity Test	As per GTP	No	Yes
		Shield Thickness		No	Yes
		Overlap test		No	Yes
	Over all cable				
		Flammability Test	IEEE 383, IEEE-332 Part -3 (Category-B)	No	Yes
		Swedish chimney test	SEN 4241475	No	Yes
		Noise interference	IEEE Transactions	No	Yes
		Dimensional checks	IS 10810	No	Yes
		Cross talk	VDE-0472	No	Yes

		Mutual capacitance	VDE-0472	No	Yes
		HV test	VDE-0815, As per GTP	No	Yes
		Drain wire continuity	VDE 0472	No	Yes
	* 1.0 All cables to be supplied shall be of type tested quality. The Bidder shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.				
	2.0 In case the Bidder is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests either in an independent laboratory or at manufacturer's works in presence of Owner's representative under this contract free of cost to the Owner and submit the reports for approval.				
	** These tests shall be carried out as per VDE0207 Part 6 & ASTM-D-2116 for TEFLON insulated & outer sheathed cables				
	*** Applicable for armoured cables only				
9	DC Power Supply System (Applicable for each model and rating)				
	1)The Type Test reports for offered rectifier module and the controller module irrespective of the rectifier bank shall be acceptable				
		Surge Withstand capability (SWC)	ANSI 37.90.1 IEEE-472, EN61000-4-12	No	Yes
		Dry Heat Test	IEC-68-2-2 or equivalent	No	Yes
		Damp Heat test	IEC-68-2-3 or equivalent	No	Yes
		Vibration test	IEC-68-2-6 or equivalent	No	Yes
		Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes
		Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes
		Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
		Degree of Protection	IS-13947 or equivalent	No	Yes
10	Battery##	As per stand	IS-10918	No	Yes

		col 4			
11	UPS (Applicable for each model and rating)				
	1) Type Test reports of same series of UPS with similar PCB's cards and controllers as the target UPS system shall be acceptable.				
	2) For Dry heat, Damp heat and vibration, the tests conducted on individual PCB's shall be acceptable.				
		Surge Withstand capability (SWC)	ANSI 37.90.1 IEEE-472, EN61000-4-12	No	Yes
		Dry Heat Test	IEC-68-2-2 or equivalent	No	Yes
		Damp Heat test	IEC-68-2-3 or equivalent	No	Yes
		Vibration test	IEC-68-2-6 or equivalent	No	Yes
		Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes
		Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes
		Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
		Degree of Protection	IS-13947 or equivalent	No	Yes
		Fuse clearing capability	Approved procedure	No	Yes
		Short circuit current capability	IEC 60146-2	No	Yes
	Voltage stabilizers	Over Load Test	Approved procedure	No	Yes
		Temp rise test without redundant fans	Approved procedure	No	Yes
	LIE / LIR	Degree of protection Test	IS-13947	No	Yes
	Flue Gas Analysers	Degree of protection Test	IS-13947	No	Yes
	Master clock	Functional test	As per Approved procedure	No	Yes
	CJC Box	Degree of protection Test	IS-13947	No	Yes
	Junction Box	Degree of protection Test	IS-13947	No	Yes
	OPC data	OPC		No	Yes

	access server Data exchange server and Historical data access server	Compliance testing			(Self certification is also acceptable)
	Conductivity type level switch	Degree of protection Test	IS-2147	No	No
	Local Gauges	Degree of protection Test	IS-2147	No	No
	Process actuated switches	Degree of protection Test	IS-2147	No	No
	Control Valves	CV Test	ISA 75.02	No	Yes
	PLCs	As per standard (col4) and cl. No. 13.03.00 below.	IEC 1131	No	No
	Flow Nozzle orifice plate	Calibration	ASME PTC BS 1042	No	Yes
	## The bidder shall submit for Owners approval the reports of all the type test as per latest IS-10918 carried out within last five years from the date of Bid opening and the test(s) should have been either conducted at an independent laboratory or in presence / owners representative. The complete type test reports shall be for any rating of Battery in a particular group based on plate dimensions being manufactured by supplier. Note: Type Tests are to be conducted only for the items, which are being supplied as a part of this Package.				

13.03.00 TYPE TESTS for PLC

- 13.03.01 All equipments to be supplied shall be of type tested quality. The bidder shall submit for Owner's approval the reports of all the type testes as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
- However if the bidder is not able to submit report of the type tests(s) conducted within last five years from the date of bid opening, or in case the type tests(s) are not found meeting the specification requirements, the Bidder shall conduct all such tests under this contract, at no additional cost to the owner either at third part lab or in presence of clients/owners representative and submit the reports for approval.
- 13.03.02 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.



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 :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- When material corelation are not available manufacturer's compliance to be provided.
- 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 :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified 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	ONE / LOT		P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR			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 :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified 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 :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



Technical specification for
CONTROL & INSTRUMENTATION

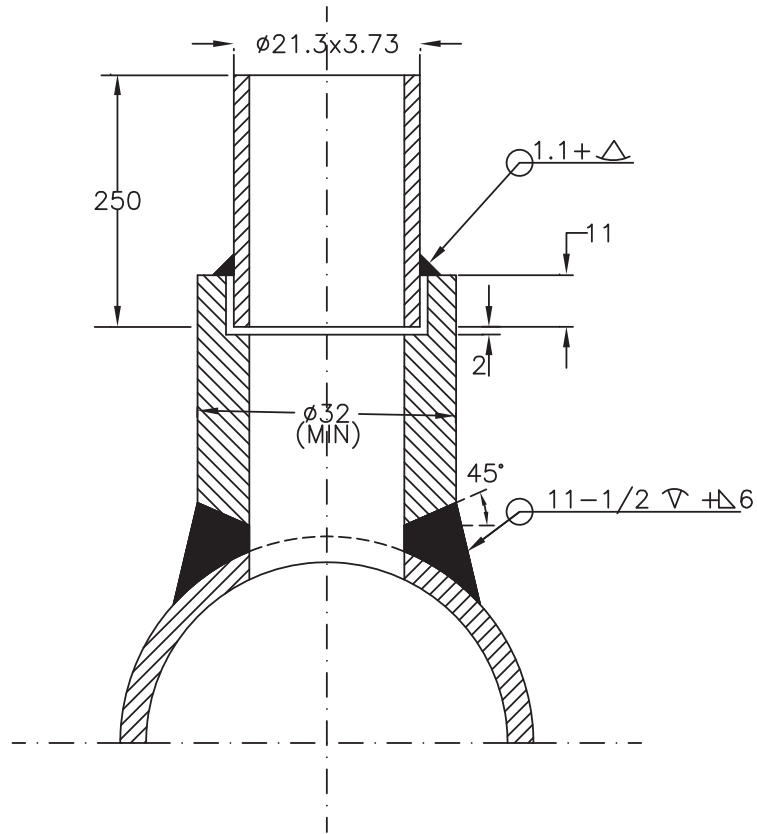
1X660MW PANKI TPS EXTN.

SECTION D

REV. NO. 00

DATE : 13.07.2018

INSTRUMENT STUB DETAILS



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1/2" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATION VALVES ARE TO BE USED FOR PRESSURE EXCEEDING 40 Kg/Cm².
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.
7. FOR PU COATED PIPE REFER SHT NO.7

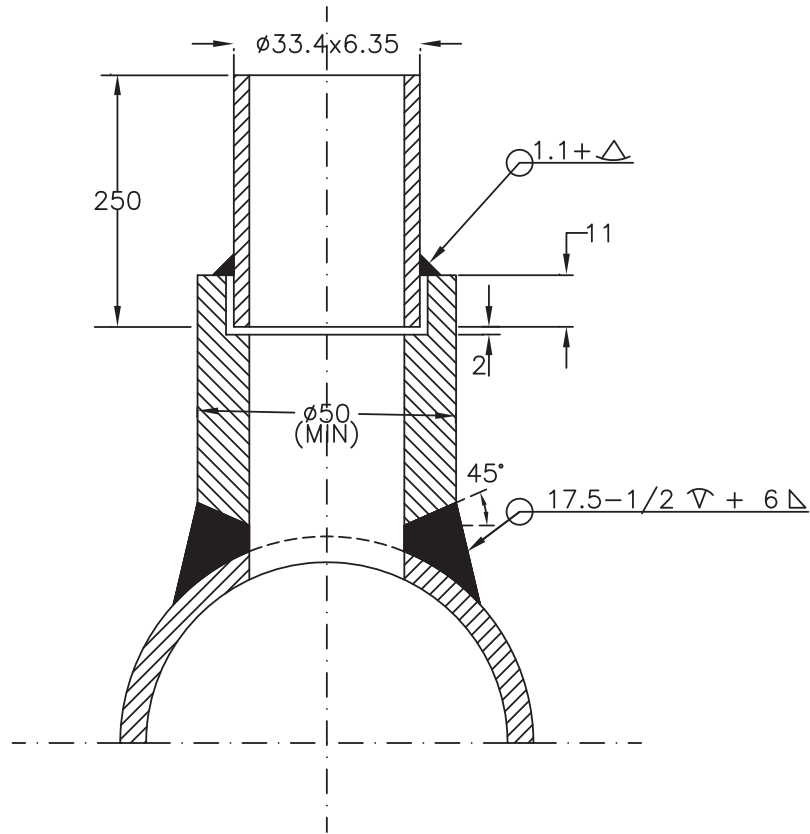


TITLE :

**STD INSTRUMENT STUB
DETAILS**
PRESSURE STUB

SYSTEM PRESS < 60Kg/Cm² & SYSTEM TEMP < 425 Deg C, Nb15 , CL3000

DRG. NO.
PE-DG-426-145-I101
REV. 00
SH. 02 OF 08



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

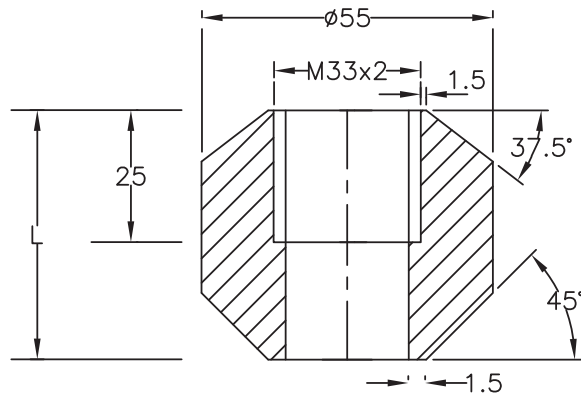


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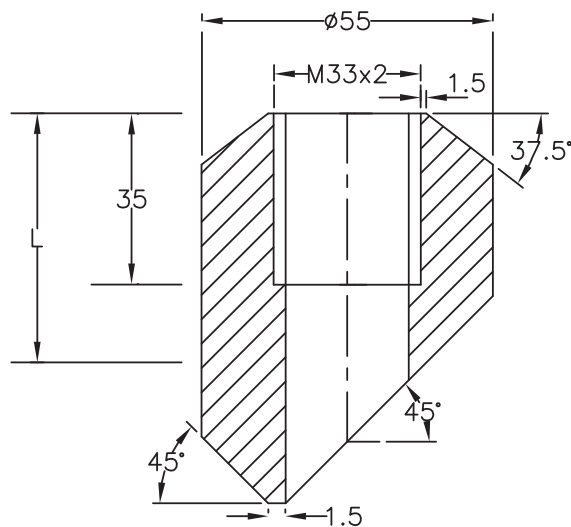
**STD INSTRUMENT STUB
DETAILS**
PRESSURE STUB

DRG. NO.
PE-DG-426-145-I101
REV. 00
SH. 03 OF 08

SYSTEM PRESS > 60Kg/Cm² & 425 Deg C < SYSTEM TEMP <= 500 Deg C , Nb25 , CL3000/6000



TEMPERATURE STUB FOR STRAIGHT IMMERSION



TEMPERATURE STUB FOR SLANT IMMERSION

NOTE :

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 64/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9 mm TO 159 mm STUB HEIGHT SHALL BE=64mm & FOR PIPE OD ≥ 219.1 mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3 mm & ABOVE. THE STUB HEIGHT FOR PIPE OD 168.3 mm TO <219.1 mm SHALL BE 64 mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9 mm TO 159 mm.
5. FOR MAIN PIPE OD'S 88.9 mm & BELOW SUITABLE EXPANDER SHALL BE USED.
6. PLEASE REFER SHEET-6 FOR THERMOWELL INSTALLATION.
7. FOR PU COATED PIPE REFER SHT NO.8

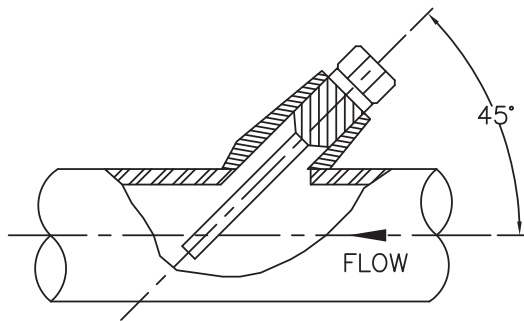
TITLE :



STD INSTRUMENT STUB
DETAILS

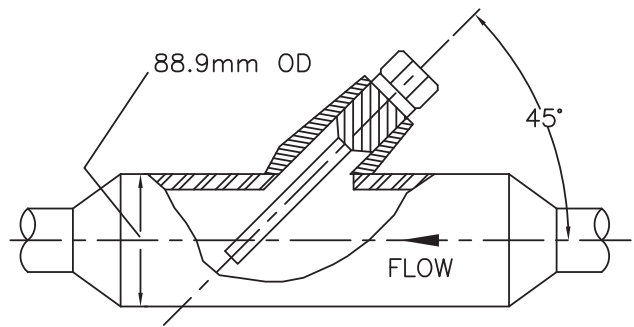
TEMPERATURE STUB

DRG. NO.
PE-DG-426-145-I101
REV. 00
SH. 05 OF 08



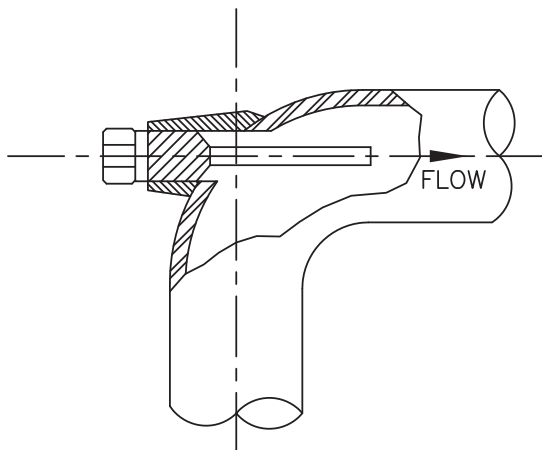
INSTALLATION TYPE-1

FOR MAIN PIPE OD 88.9mm to 159mm



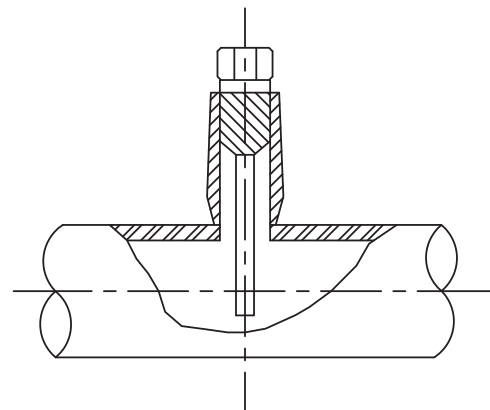
INSTALLATION TYPE-2

FOR MAIN PIPE OD BELOW 88.9mm



INSTALLATION TYPE-3

FOR MAIN PIPE OD 88.9mm & BELOW



INSTALLATION TYPE-4

FOR MAIN PIPE OD 168.3mm & ABOVE



TITLE :

STD INSTRUMENT STUB
DETAILS

THERMOWELL INSTALLATION

DRG. NO.
PE-DG-426-145-I101
REV 00
SH. 06 OF 08



Technical specification for
CONTROL & INSTRUMENTATION

1X660MW PANKI TPS EXTN.

SECTION D

REV. NO. 00

DATE : 13.07.2018

LOCAL CONTROL PANEL SPECIFICATION & QUALITY PLAN

6.10.00 CONSTRUCTIONAL FEATURES OF LOCAL CONTROL PANELS, CONSOLES, CONTROL Desk, CUBICLES & ENCLOSURES

- i. All control panels, cubicles, consoles, SOV panels and enclosures provided anywhere for subject plant per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates (CRCA). The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

Side and top – not less than 1.6 mm

Door – not less than 2.0 mm

Mounting plate – 2.5 mm

Base metal plate - 2.5 mm

Gland plate – 3 mm

- ii. The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three/four -point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four -point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

- iii. All panels shall be mounted on vibration dampers, which are secured to C-channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.
- iv. In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.
- v. Exhaust Fans with louvers & filters shall be provided on upper side to remove hot air in all consoles and panels.
- vi. Fire & Smoke detectors shall be provided inside the Control room mounted system/control cabinets.
- vii. Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/ PLC/annunciation & suitably grouped.
- viii. All the panels shall be equipped with Anti vibration pad of min. 15 mm size thickness. Cable gland plate thickness shall be 3 mm. C Channel height shall be min. 100 mm.
- ix. Doors shall be provided with neoprene/polyurethane gasket only. The front and rear doors shall be of full height .
- x. Protection class shall be as specified at Vol. V, Part B, chapter 1.
- xi. All the cable entries shall be at the bottom of electronic cubicles/control panels.
- xii. Control panels shall be provided with proper arrangement and hardware to terminate the inert gas required for fire protection.
- xiii. 25x6 mm copper ground bus to be provided for each panel/control desk.
- xiv. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals of each type.
- xv. For Panels/cubicles internal wiring details, Bidder to refer Vol. V, Part B, Chapter 9.

6.11.00 TERMINATION/Marshalling CABINETS & Interposing Relay Panel

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source



of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, HW Annunciation windows and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators, bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals.

Wiring shall be 650V grade. PVC insulated FRLS stranded copper wire.

6.12.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6

mm. As an alternative, single coat of anodic dip coat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.

The Bidder shall furnish sufficient touch-up paint for one complete finish coat on all exterior factory applied painted surface of each item of equipment.

The finish colours for exterior and interior surfaces shall conform to the following shades:

a) Exterior - RAL 7032/RAL 7035.

b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized by owner during detailed engineering shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.13.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 5/15A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

6.14.00 Panel Cooling Fans (for ventilation of the DDCMIS/ PLC / DCS & other cabinets)

Filter Fan for electrical cabinets and enclosures to be used with 120 V or 230 V AC versions having very low acoustic noise and lower power consumption. The fans must have UL approval and should have air flow volume as per the cabinet requirement. Wherever required, the EMC filter fans may be used. Fans should have a life of 50,000 Hours at 40 Deg C. Fan Housing, cover should be of V0 material as per UL94. Filter mat should be compliant to EU3 according to DIN 24185 standard and have a filtering degree of 80 to 90 %. The Ambient temperature range °C should be -10 to +70 Deg C and Protection class should be IP 54. Filter Material shall be Synthetic fibre with progressive construction, temperature resistant to +100°C, self extinguishing, Class F1 as per DIN 53438 standard.

6.15.00 Panel Thermostat (for temperature control of the DDCMIS/PLC/DCS panel – to be connected to switch On/Off Fan/Heater)

The panel thermostat shall be DIN Rail Mounted with an inbuilt snap action thermostatic bimetal sensor and shall be connected in series with the load without any additional supply voltage. The panel thermostat shall be available in setting temperature range of -20 deg C to 40 deg C or 0 to 60 deg C with separate modules for NO or NC contact. The electrical life at rated load AC1 shall be 1 Lakh switching cycles and shall work at an ambient temperature of -45 to +80 deg C. With AgNi contact material for switching, the contact current carrying

capacity shall be 10 Amp at a rated voltage of 250 V AC with a dielectric strength between open contacts of 500 V AC and shall have UL approval.

6.16.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermo magnetic type MCB. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.17.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.

6.18.00 QUANTITIES

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

6.19.00 Design Criteria for Control Rooms:

The interiors of the each control Room shall be aesthetically designed with modern designs and technologies. The bidder shall have 2-D and 3-D software for designing the control room layouts. The bidder shall have thorough knowledge on Indian power plant control room requirements. Control rooms shall also be designed as per standard "ISO 11064 (1-7) - Ergonomic design of control centres".



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 ^{\$}			Remarks
									P	W	V	
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics \$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor												



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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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 ^{\$}			Remarks
									P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check 4. I.R. 5. H.V. 6. Calibration 7. Pick up / Drop off Voltage	CR CR CR MA MA MA MA	Visual Scrutiny of Type / Routine T.Cs. Electrical Electrical Electrical Electrical	Sample 100% Sample+ 100% 100% 100% 100%	BHEL Spec. and BOM Relevant standard Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue	BHEL Spec. and BOM Relevant standard Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue Relevant standard & Catalogue	Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2	--- --- --- --- --- --- ---	--- --- --- --- --- --- ---	+ for relay & contactors only @ for all components except relays & contactors. 1
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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: **PE-QP-999-145-I056**

VOLUME IIB

SECTION D

REV. NO. **01** DATE: **22-02-2008**

SHEET 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	---	---	
6.0	IN PROCESS 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	---	---	
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: **PE-QP-999-145-I056**

VOLUME IIB

SECTION D

REV. NO. **01** DATE: **22-02-2008**

SHEET 4 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: **PE-QP-999-145-I056**

VOLUME IIB

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 ^{\$}			Remarks
									P	W	V	
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	---	---	
12.	FINAL 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	

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								VOLUME		IIB		
								SECTION		D		
								REV. NO.		01		
								DATE:		22-02-2008		
		SHEET		6		OF		7				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks
									P	W	V	
		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	

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									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	FUNCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibration	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	

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Technical specification for
CONTROL & INSTRUMENTATION

1X660MW PANKI TPS EXTN.

SECTION D

REV. NO. 00

DATE : 13.07.2018

APPLICABLE CABLE TYPES

Cable Sizes for 1X660MW TPS PANKI EXTN.	
Sl no.	Cable Type
G-TYPE	
1	2P X 0.5 sqmm
2	4P X 0.5 sq mm
3	8P X 0.5 sqmm
4	12P X 0.5 sqmm
F-TYPE	
1	4P X 0.5 sqmm
2	8P X 0.5 sqmm
3	12P X 0.5 sqmm
4	20P X 0.5 sqmm
CONTROL CABLE	
1	3C X 2.5 sqmm



Technical specification
for
1X660 MW TPS PANKI EXTN.

REV. NO. 00 DATE : 04.04.2019

DRIVE CONTROL PHILOSOPHY

OWS

BUS

DDCMIS

BINARY INPUT

BINARY OUTPUT
\$\$

MARSHALLING PANEL
TB

COMMON

XB46

XB11

XB12

XB92

COMMON

XB91

BL

RD

GE

YE

GR

BN

WT

BK

G-TYPE 4 PAIR 0.5SQMM
INST.CABLE

SWGR MODULE

* MCC DISTURBANCE
(NC)

STATUS
ON (NO)

OFF (NC)

COMMAND OFF

COMMAND ON

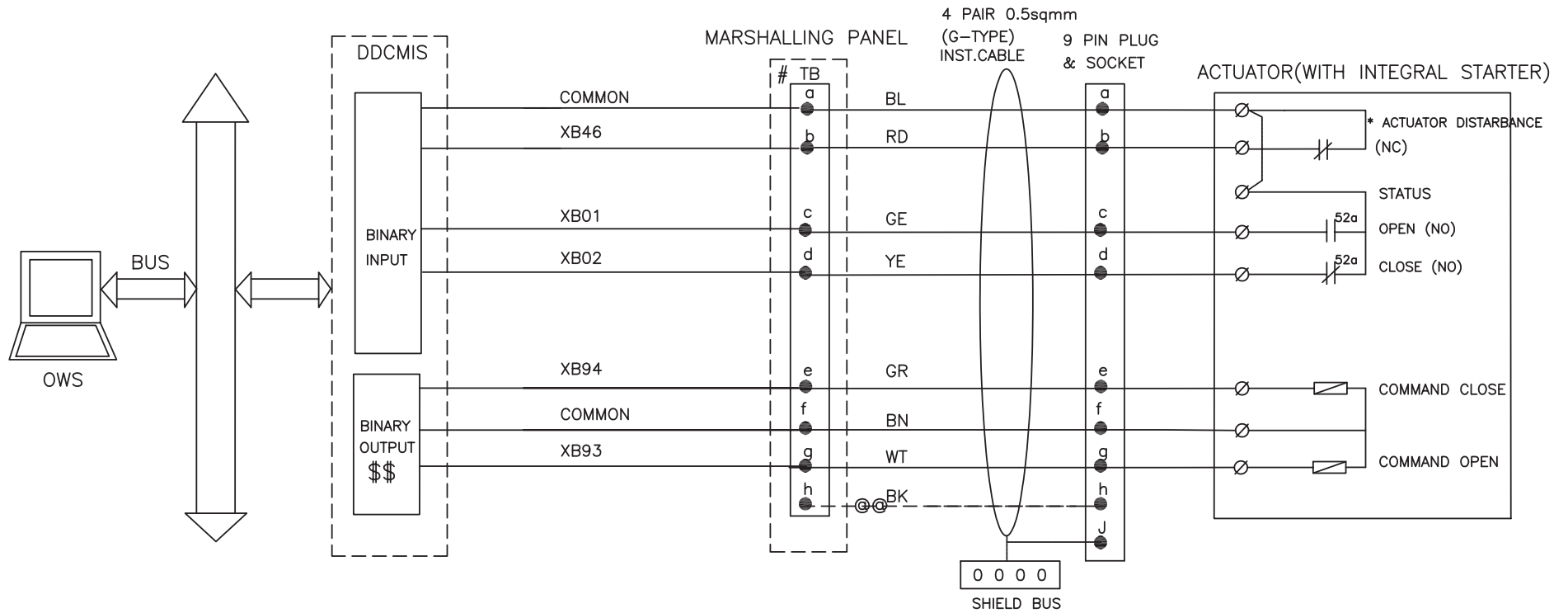
EMG STOP

0 0 0 0
SHIELD BUS

NOTE:-1 \$\$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
 NOTE:-2 # 8 LEVEL TERMINAL BLOCK
 NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE
 TERMINATION SEQUENTIALLY.
 NOTE:-4 * MCC DISTURBED= THERMAL O/L OPT/CONT SUPP FAIL/EPB OPTD
 /DRIVE POWER SUPPLY OFF

	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
	DDCMIS INTERFACE WITH LT MCC (LT)	SHT	05 OF 34

DDCMIS INTERFACE WITH BID/MOV/MOD



NOTE:-1 \$\$ REDUNDANT OUTPUTS WHEREVER APPLICABLE

NOTE:-2 # 8 LEVEL TERMINAL BLOCK

NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE
TERMINATION.

NOTE:-4 * DISTURBANCE=LOSS OF POWER SUPPLY(1PHASE/3PHASE)/LOSS OF
CONTROL SUPPLY/MOTOR THERMOSTAT TRIP/THERMAL OVER LOAD/
TORQUE SWITCH OPERATED, LOCAL/OFF/REMOTE SWITCH IN LOCAL/OFF POSITION



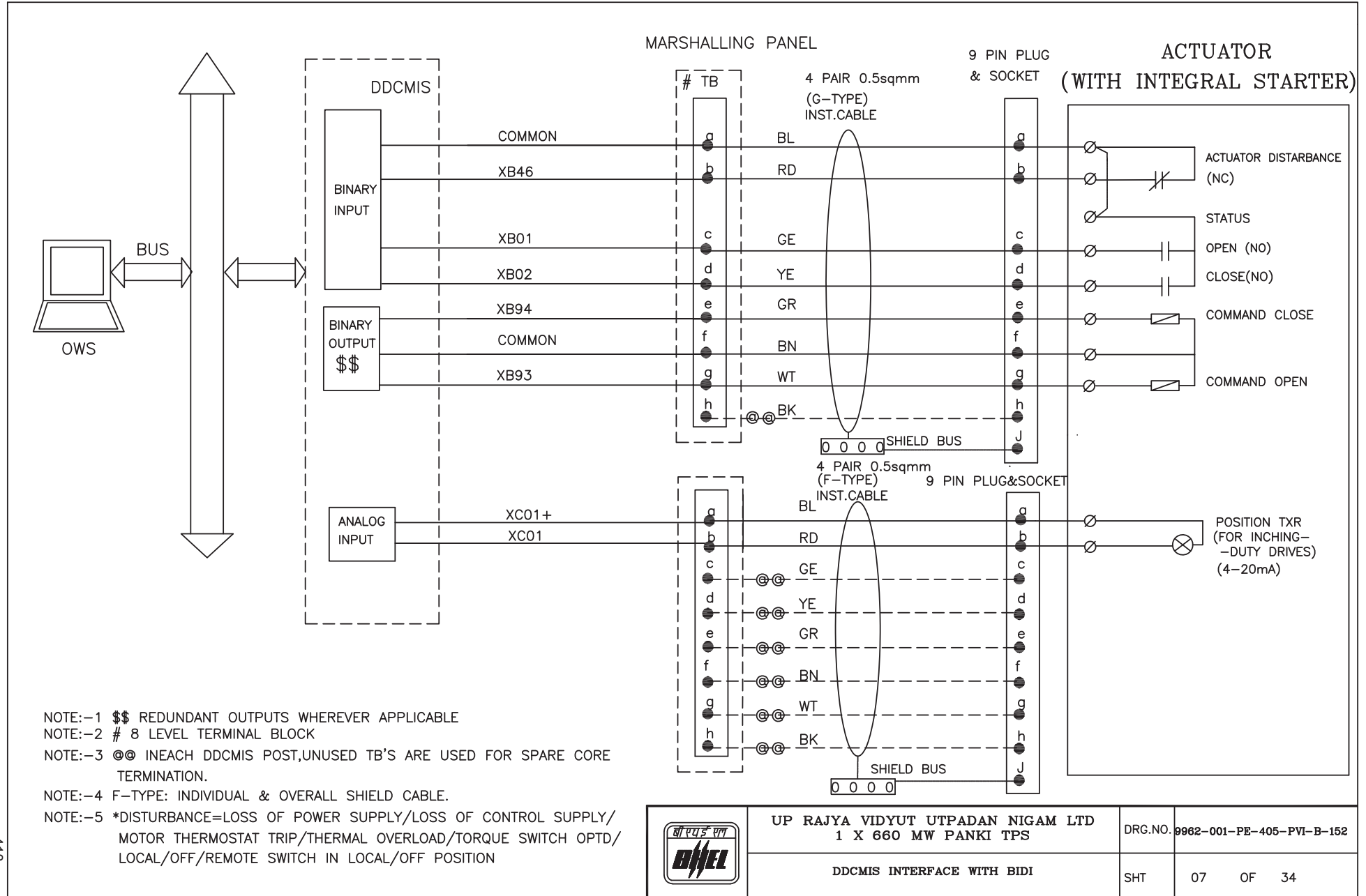
UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DDCMIS INTERFACE WITH BID

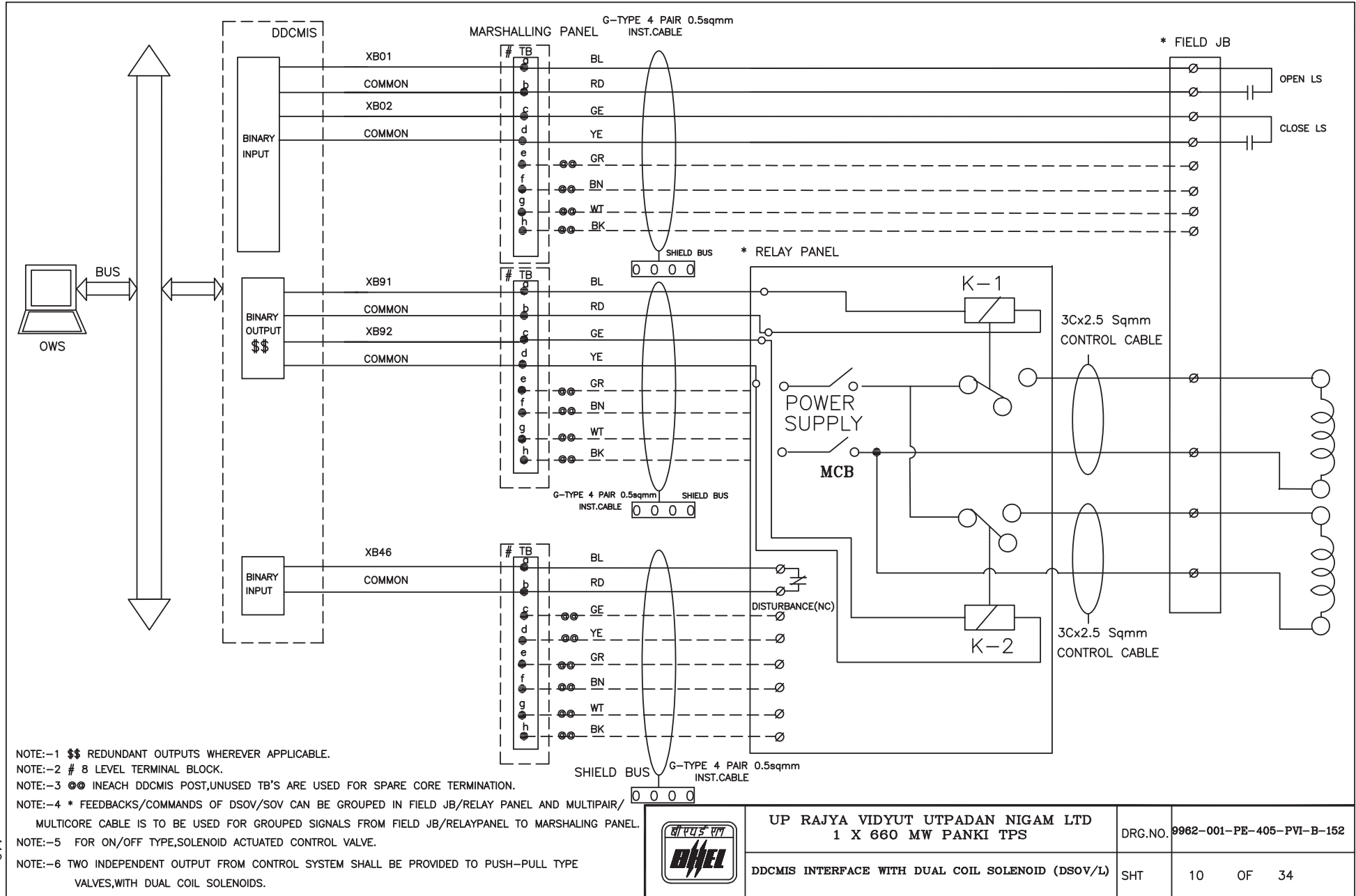
DRG.NO.	9962-001-PE-405-PVI-B-152

SHT	06	OF	26

DDCMIS INTERFACE WITH BIDI/MODI/MOVI



DDCMIS INTERFACE WITH DUAL COIL SOLENOID (DSOV/L)



UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

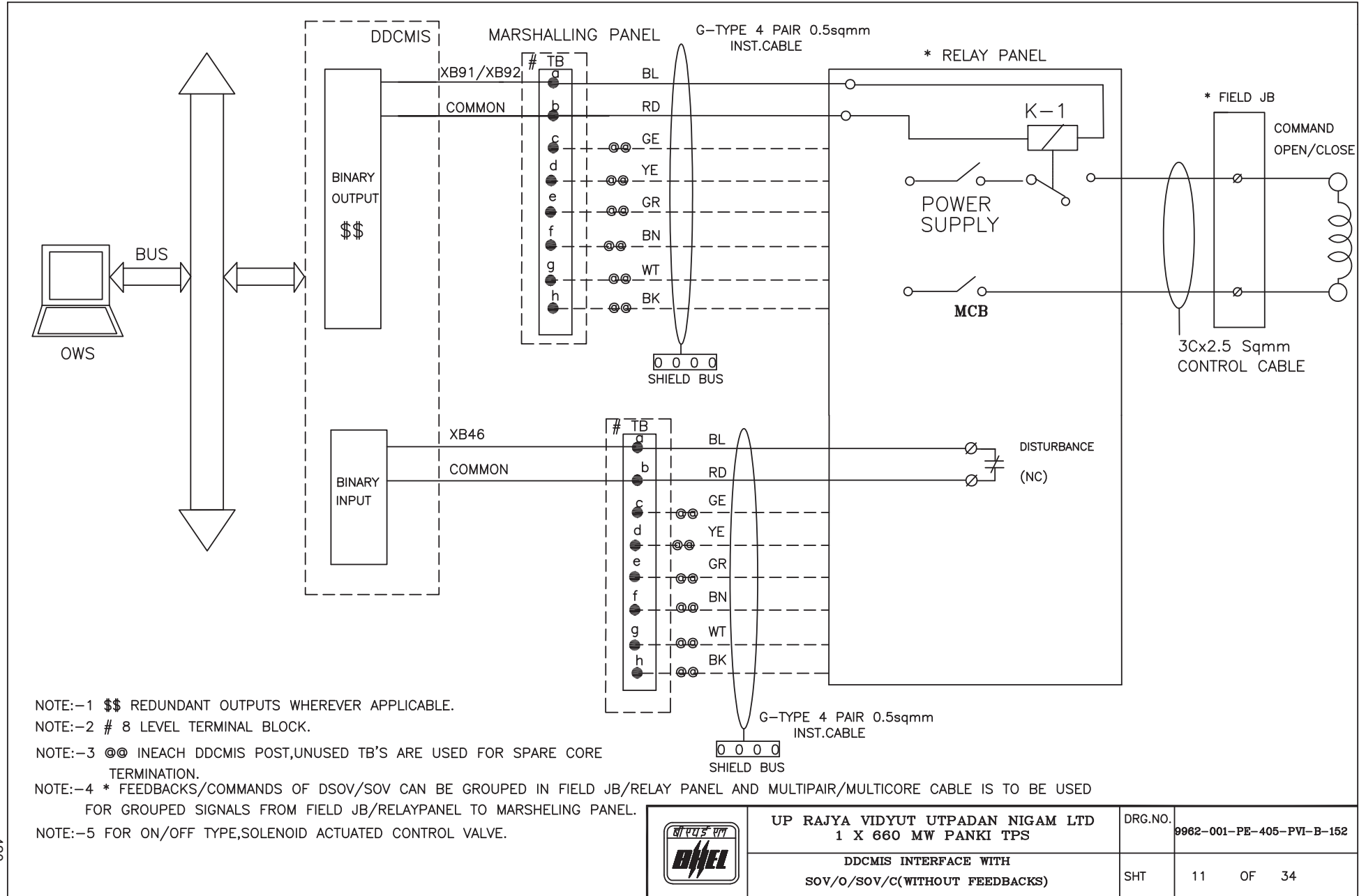
DRG.NO. 9962-001-PE-405-PVI-B-152

DDCMIS INTERFACE WITH DUAL COIL SOLENOID (DSOV/L)

SHT

10 OF 34

DDCMIS INTERFACE WITH SOV/O/SOV/C(WITH OUT FEEDBACKS)



UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DDCMIS INTERFACE WITH
SOV/O/SOV/C(WITHOUT FEEDBACKS)

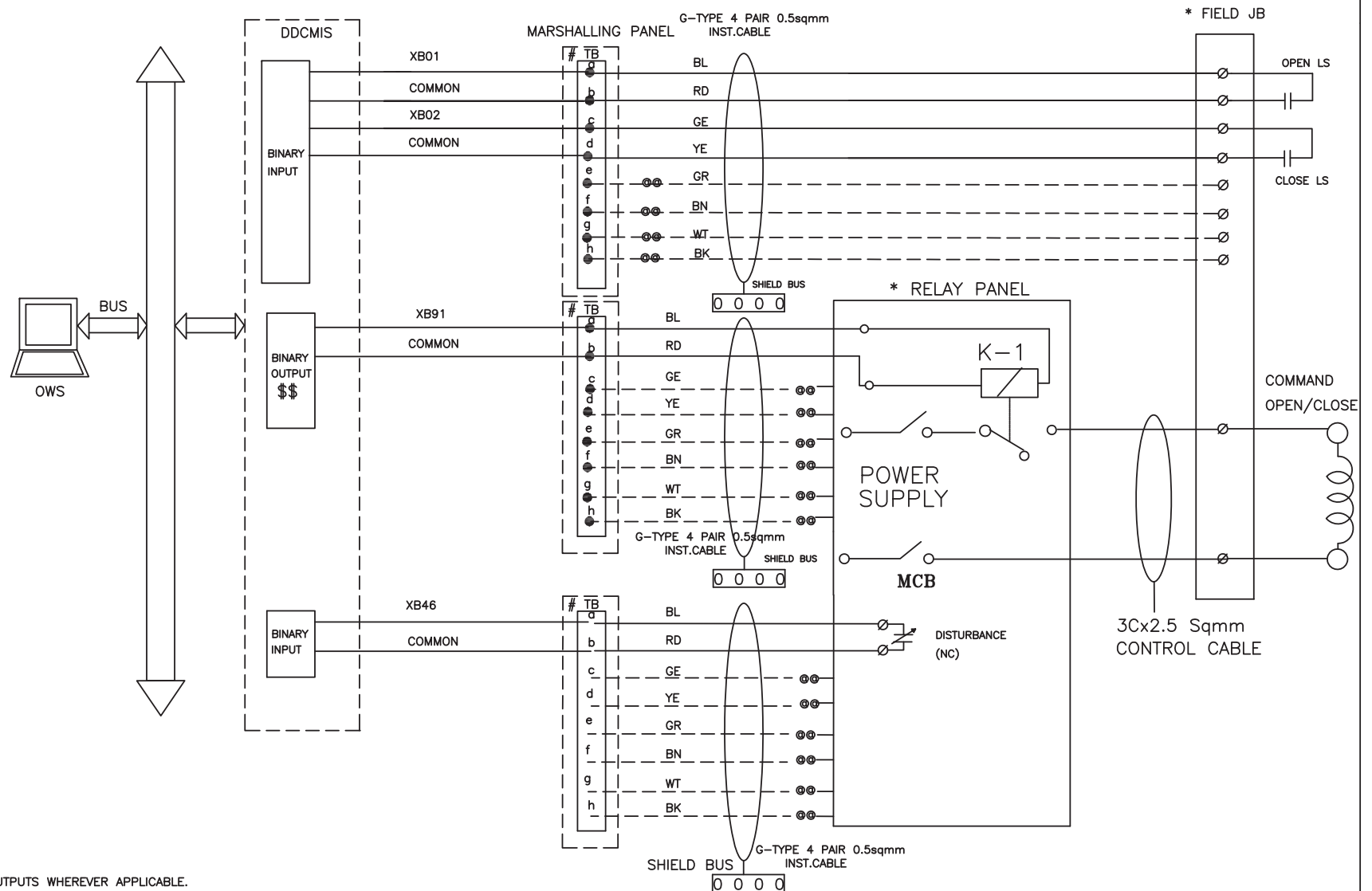
DRG.NO.

9962-001-PE-405-PVI-B-152

SHT

11 OF 34

DDCMIS INTERFACE WITH SOV/O/L(WITH FEED BACKS)



NOTE:-1 \$\$ REDUNDANT OUTPUTS WHEREVER APPLICABLE.

NOTE:-2 # 8 LEVEL TERMINAL BLOCK.

NOTE:-3 @ @ IN EACH DDCMIS POST, UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.

NOTE:-4 * FEEDBACKS/COMMANDS OF DSOV/SOV CAN BE GROUPED IN FIELD JB/RELAY PANEL AND MULTIPAIR/
MULTICORE CABLE IS TO BE USED FOR GROUPED SIGNALS FROM FIELD JB/RELAY PANEL TO MARSHALLING PANEL.

NOTE:-5 FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.



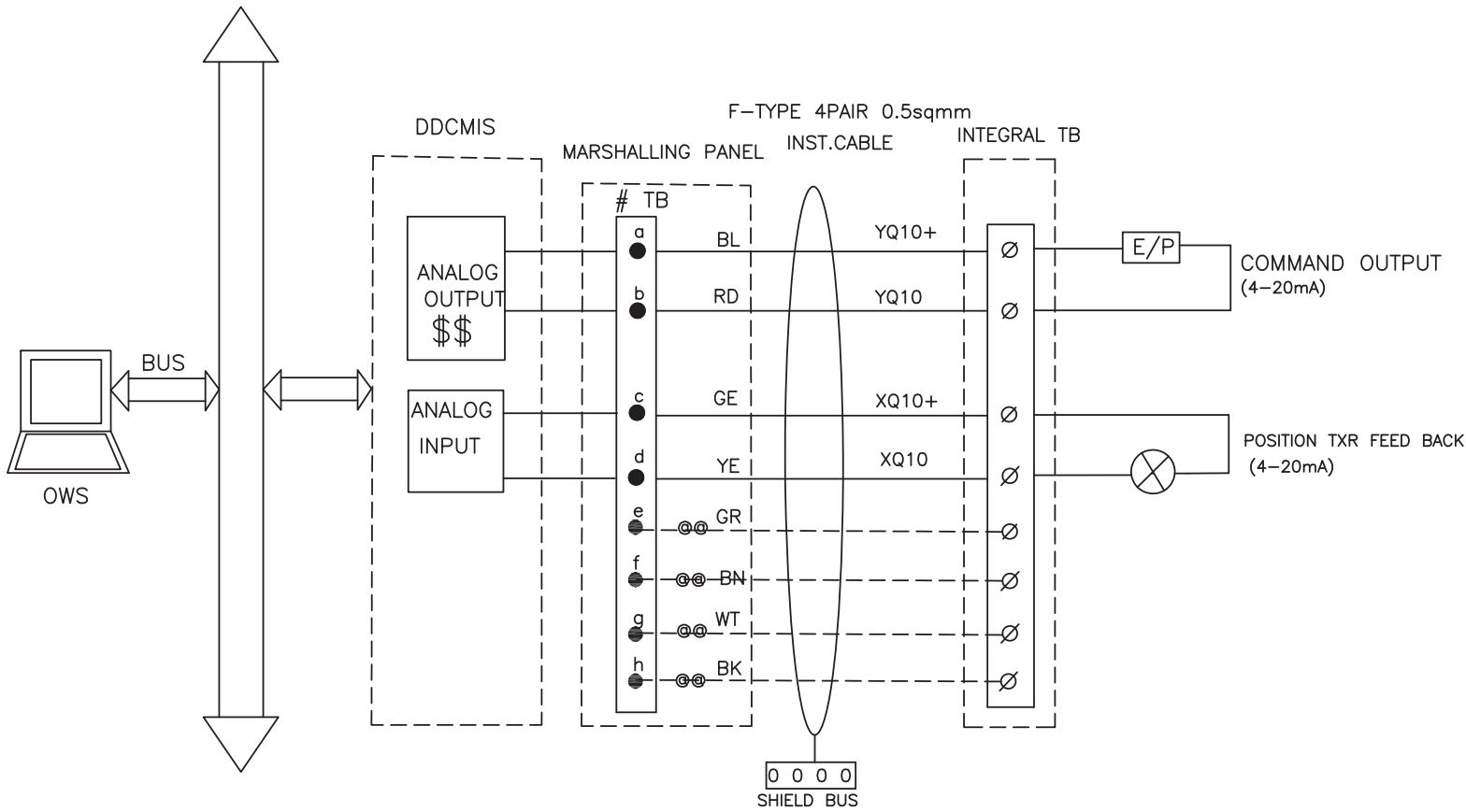
UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DRG.NO. 9962-001-PE-405-PVI-B-152

DDCMIS INTERFACE WITH SOV/O/L(WITH FEEDBACKS)

SHT 12 OF 34

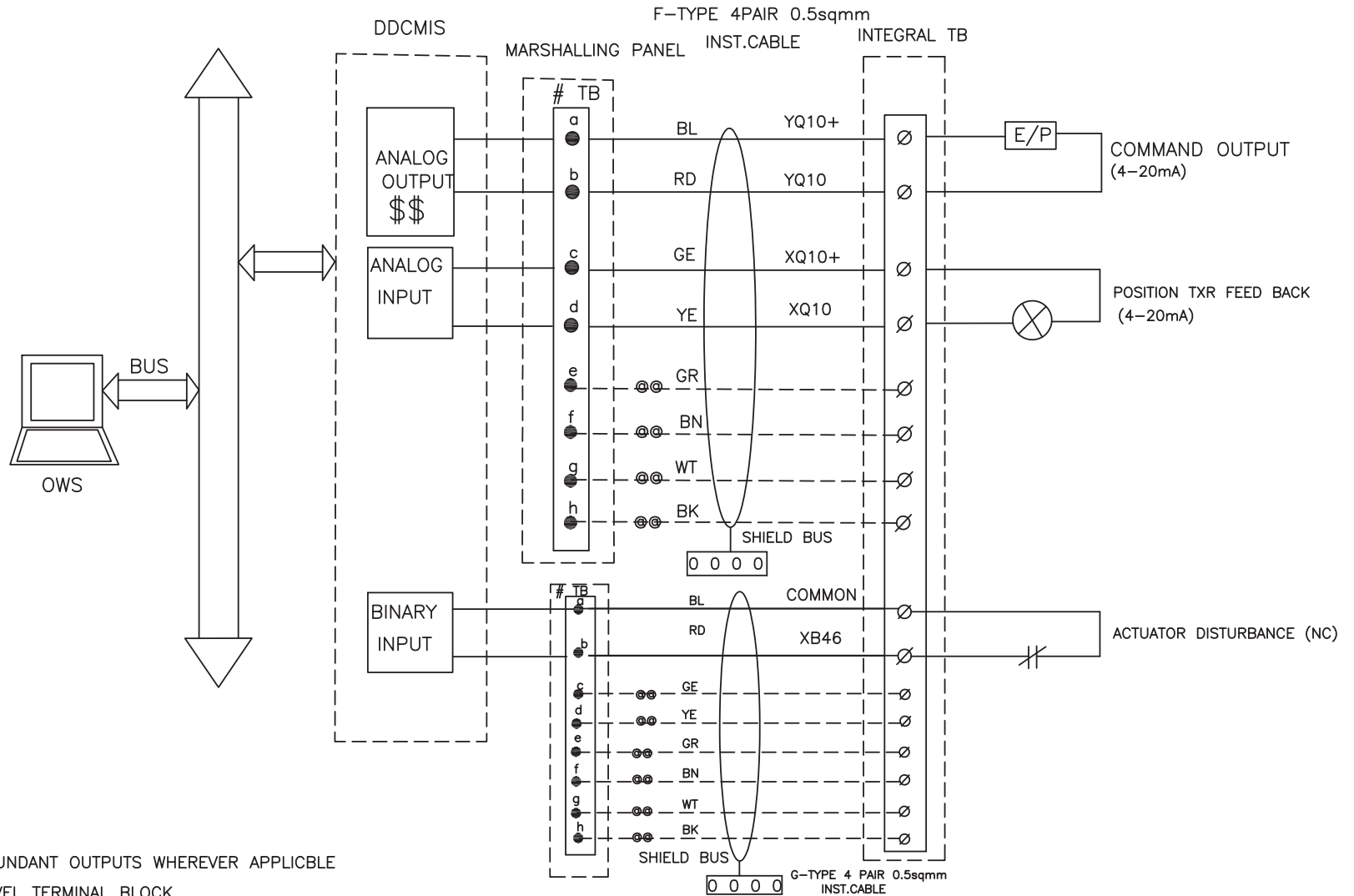
INTERFACE FOR MODULATING DRIVES - CLCS



- NOTE:-1 \$\$ REDUNDANT OUTPUTS WHEREVER APPLICBLE
- NOTE:-2 # 8 LEVEL TERMINAL BLOCK
- NOTE:-3 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.
- NOTE:-4 F-TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
	INTERFACE FOR MODULATING DRIVES - CLCS	SHT	14 OF 34

INTERFACE FOR MODULATING DRIVES – CLCS–M



NOTE:-1 \$\$\$ REDUNDANT OUTPUTS WHEREVER APPLICABLE

NOTE:-2 # 8 LEVEL TERMINAL BLOCK

NOTE:-3 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:-4 F-TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.



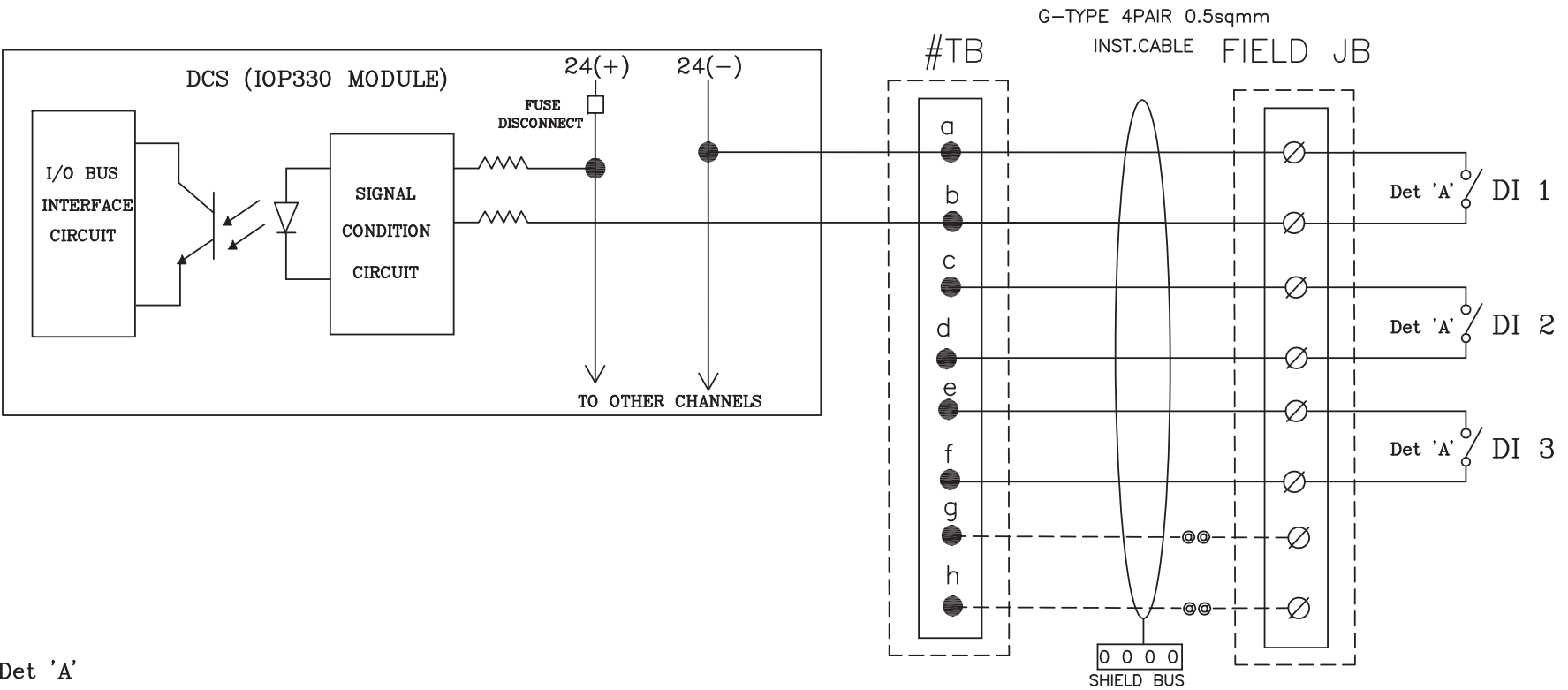
UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DRG.NO. 9962-001-PE-405-PVI-B-152

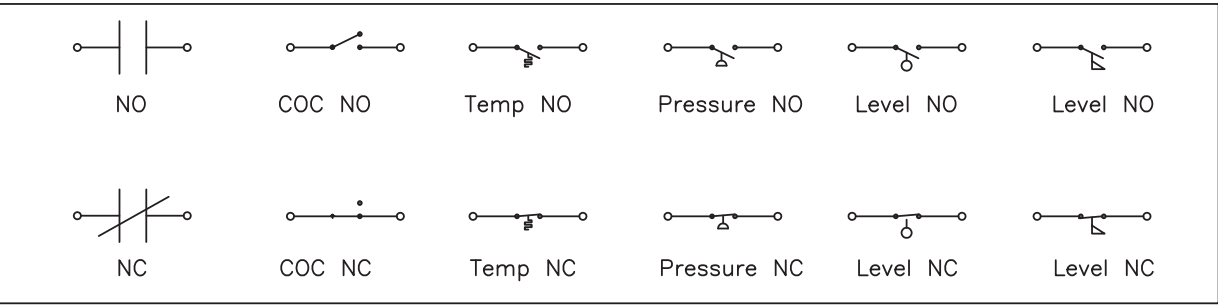
INTERFACE FOR MODULATING DRIVES – CLCS–M

SHT 15 OF 34

DDCMIS INTERFACE WITH DIGITAL INPUT SIGNAL



Det 'A'



NOTE:-1 #8 LEVEL TERMINAL BLOCK.

NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

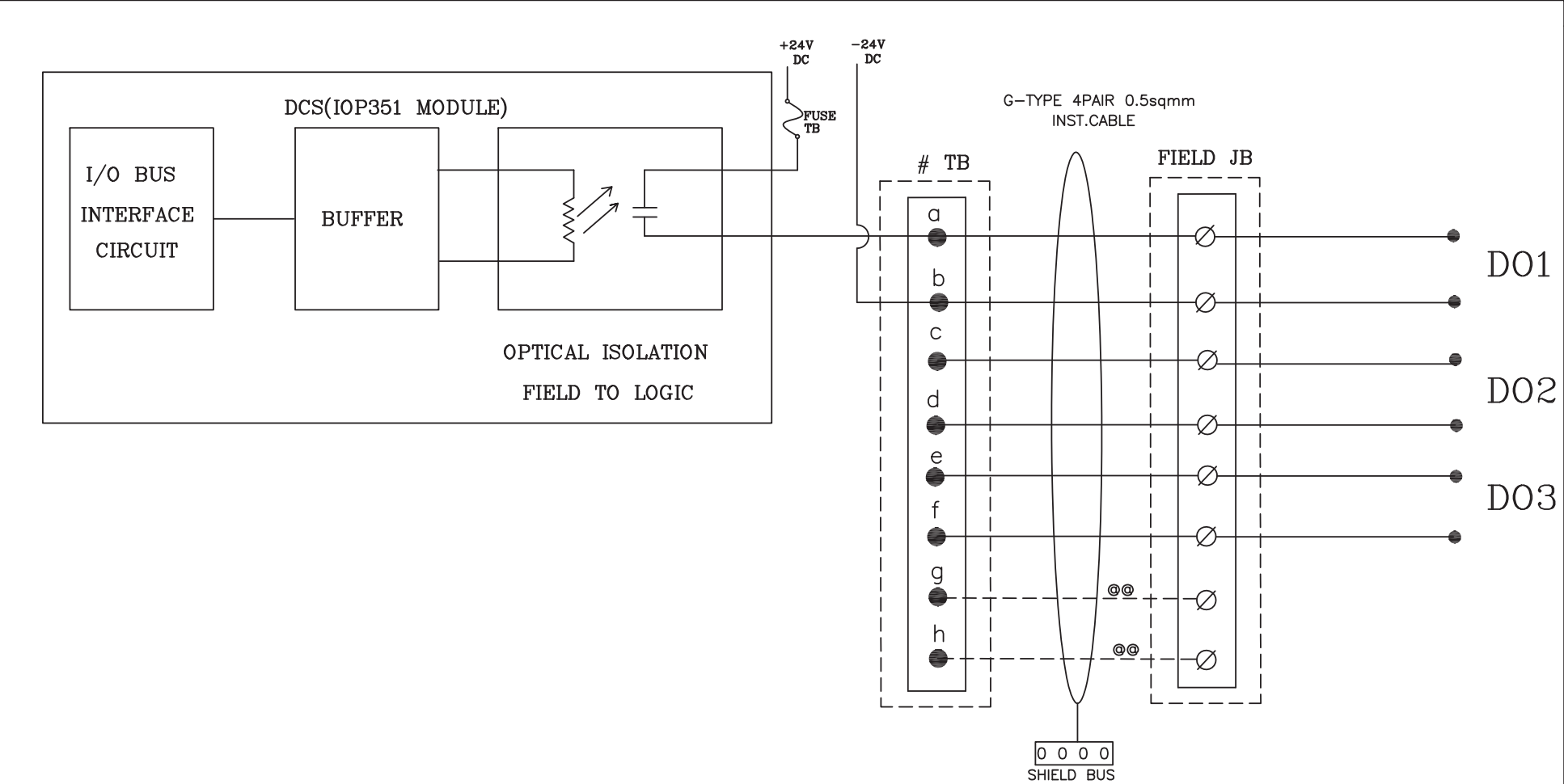


UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DDCMIS INTERFACE WITH DIGITAL INPUT SIGNAL

DRG.NO.	9962-001-PE-405-PVI-B-152
DATE	11.02.2019
REV.NO.	01
SHT	23 OF 34

DDCMIS INTERFACE WITH DIGITAL OUTPUT SIGNAL

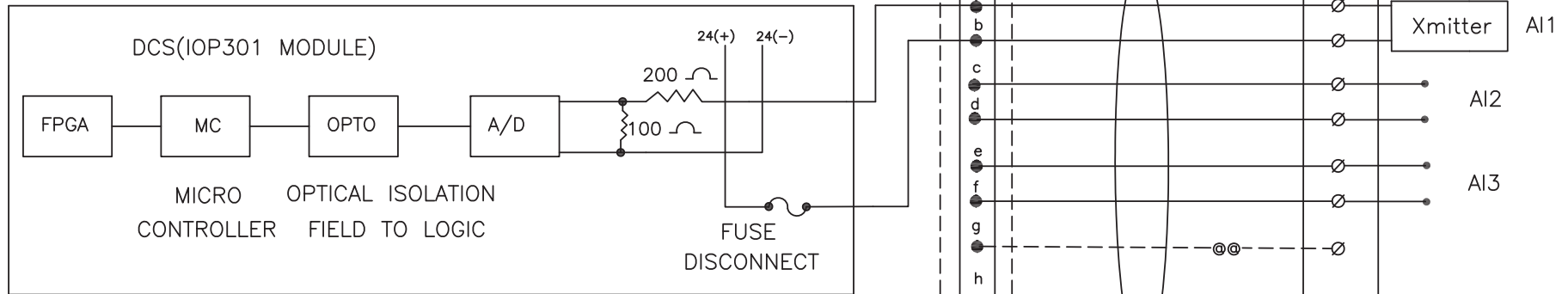


NOTE:-1 #8 LEVEL TERMINAL BLOCK.
NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

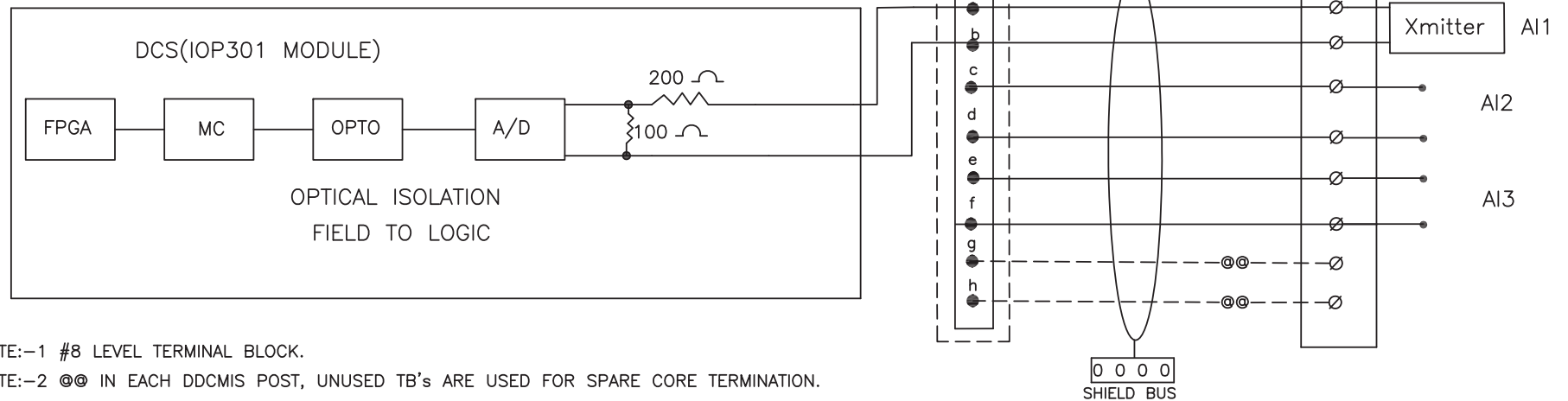
	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152		
		DATE	11.02.2019		
		REV.NO.	01		
		SHT	24	OF	34

DDCMIS INTERFACE WITH ANALOG INPUT SIGNAL

AI INTERFACE(4-20mA POWERED BY SYSTEM)



AI INTERFACE(4-20mA POWERED EXTERNALLY)



NOTE:-1 #8 LEVEL TERMINAL BLOCK.

NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:-3 F-TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.



UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DDCMIS INTERFACE WITH ANALOG INPUT SIGNAL

DRG.NO.	9962-001-PE-405-PVI-B-152

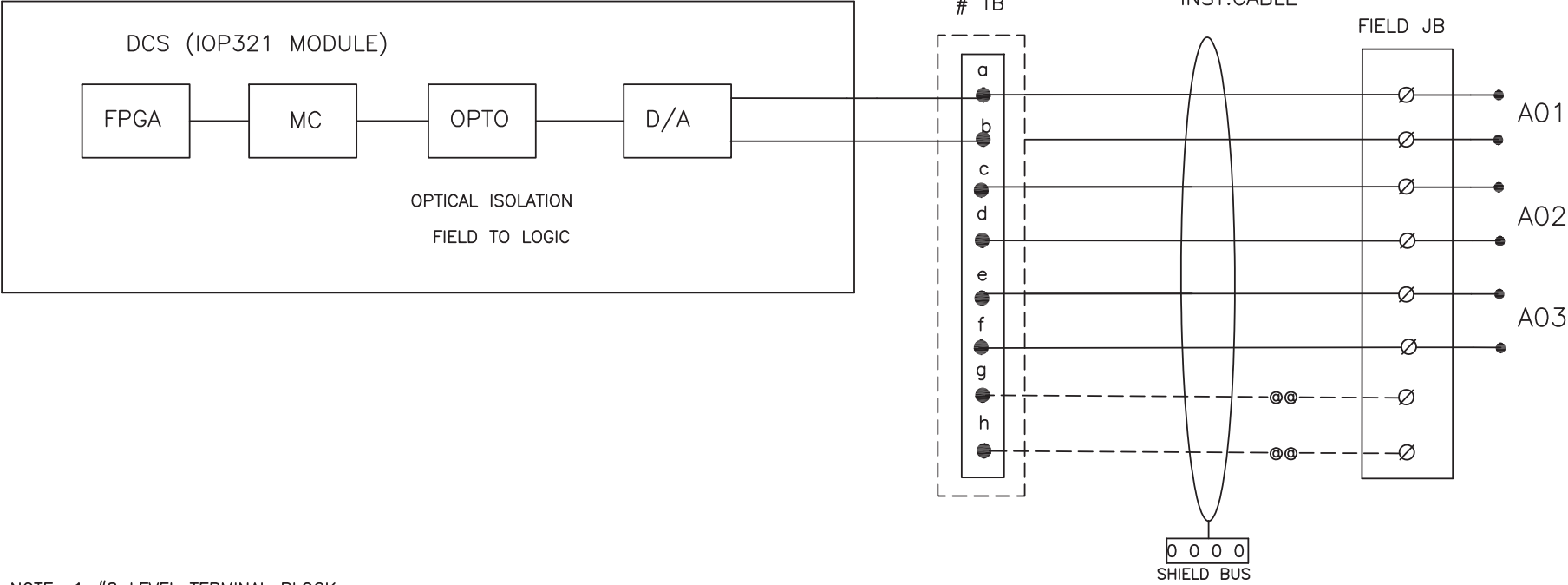
DATE	11.02.2019

REV.NO.	01

SHT	25	OF	34

DDCMIS INTERFACE WITH ANALOG OUTPUT SIGNAL

AO INTERFACE



NOTE:-1 #8 LEVEL TERMINAL BLOCK.
NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.
NOTE:-3 F-TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.



UP RAJYA VIDYUT UTPADAN NIGAM LTD
1 X 660 MW PANKI TPS

DDCMIS INTERFACE WITH ANALOG OUTPUT SIGNAL

DRG.NO.	9962-001-PE-405-PVI-B-152
DATE	11.02.2019
REV.NO.	01
SHT	26 OF 34



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : III

SUB-SECTION:

REV. NO. 00

SECTION – III



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : III

SUB-SECTION:

REV. NO. 00

SCHEDULE OF PRE-BID CLARIFICATION

All clarification from the Technical Specification shall be filled in by the BIDDER clause by clause in this format only.

VOLUME	SECTION	CLAUSE NO.	PAGE NO.	SPECIFICATION REQUIREMENT	CLARIFICATION	REASONS FOR CLARIFICATI ON



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : III

SUB-SECTION:

REV. NO. 00

COMPLIANCE CUM CONFIRMATION SCHEDULE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer:

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.
2. QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.
3. QP will be subject to BHEL/Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc.
The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.
4. All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.
5. There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.
6. The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.
7. The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).
8. All sub vendors shall be subject to BHEL/CUSTOMER approval.
9. Any special tools & tackles, if required, shall be in bidder's scope.
10. Performance guarantee test parameters shall stand valid till the satisfactory completion of Performance guarantee test and its acceptance by BHEL/Customer.
11. Prices for recommended spares (if any) for three year operation shall be furnished separately and not to be included in the base price.



TITLE :
1X660 MW PANKI TPS EXTN.

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-426-168-A001

SECTION : III

SUB-SECTION:

REV. NO. 00

DECLARATIONS

I certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidders Company Name

Authorized representative's Signature

Name

Bidder's Name

The bidder hereby agrees to fully comply with the requirements and intent of this specification for the price indicated.

SCHEDULE OF DEVIATIONS WITH COST OF WITHDRAWAL



PROJECT:- 1X660 MW PANKI TPS EXTN.

HYDROGEN GENERATION PLANT

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOLUME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF withdrawal OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF withdrawal OF DEVIATION IS APPLICABLE	NATURE OF COST OF withdrawal OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION

TECHNICAL DEVIATIONS

COMMERCIAL DEVIATIONS

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATIONS	SIGN & DATE	

NOTES:

- For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
- For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
- All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
- Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
- Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
- Bidder shall furnish price copy of above format along with price bid.
- The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
- Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
- For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
- Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
- 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.
- Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
- In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
- In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.