




Clause No.	CABLING EARTHING AND LIGHTNING PROTECTION		
		..... (Bidder's Name)	
	CABLE SUPPORT SYSTEM		
1.00.00	Cable Trays, Fittings & Accessories		
1.01.00	Makers, Name, Country of manufacturer (Shall be as per approved QA make)	.....	.....
1.02.00	Type & Material of cable tray	.....	.....
2.00.00	Conduit Pipes & Accessories		
2.01.00	Maker's Name and Country of manufacture	.....	.....
2.02.00	Material	.....	.....
2.03.00	Class of duty	.....	.....
2.04.00	Type of Coating	.....	.....
2.05.00	Applicable Standard	.....	.....
3.00.00	Junction Boxes		
3.01.00	Maker's Name and Country of manufacture	.....	.....
3.02.00	Material	.....	.....
3.03.00	Applicable Standard	.....	.....
3.04.00	Degree of Protection	.....	.....
4.00.00	Cable Glands		
4.01.00	Maker's Name and Country of manufacture	.....	.....
4.02.00	Type of cable gland	.....	.....
4.03.00	Applicable Standard	.....	.....
4.04.00	Material	.....	.....

Clause No.	CABLING EARTHING AND LIGHTNING PROTECTION		
	..... (Bidder's Name)		
5.00.00	Cable lugs & Terminals		
5.01.00	Maker's Name & Country of Manufacturer	.....	.....
5.02.00	Material	.....	.....
5.03.00	Applicable Standard		
	(i) HT	.....	.....
	(ii) LT	.....	.....
6.00.00	Earthing System		
	Equipment earthing		
	i) Material	.....	.....
	ii) Size	.....	.....
	iii) Applicable Standard	.....	.....
7.00.00	Lightning Protection System		
	i) Applicable Standard	.....	.....
	ii) Size & material for Air termination and down conductor	.....	.....
8.00.00	Cable Jointing/Termination Kits		
	(a) Maker's Name & Country of Manufacturer	.....	.....
	(b) Type of System		
	(i) Termination H.T./L.T.	.....	.....
	(ii) Joints H.T./L.T.	.....	.....
	(c) Outdoor/Indoor	.....	.....

Clause No.	CABLING EARTHING AND LIGHTNING PROTECTION	
9.00.00	<p style="text-align: right;">..... (Bidder's Name)</p> <p>Cable Tray Support System</p> <p>(a) Maker's Name, Country of Manufacturer</p> <p>(b) Type & Material of cable tray support system</p> <p>(c) Catalogue and indicative sketch attach as annexure No.</p>	

LIGHTING (H₂ GENERATION PLANT)

Clause No.

ELECTRICAL ACTUATOR



.....
(Bidder's Name)

ACTUATOR DATA SHEET:

Sl.No.	Description	Unit	Data
1.	Actuator Manufacturer (Shall be as per approved QA make)		
2.	Model		
3.	Torque Range & RPM	Kg-M	
4.	Duty Cycle (ON-OFF/Regulating)		
5.	Local/Remote Selector Switch (Lockable)		
6.	Enclosure/Degree of Protection		
7.	Admissible Ambient Temperature	°C	
8.	Average/Nominal Output	KW	
9.	Rated Voltage	V	
10.	Rated Frequency	Hz	
11.	No. of Phases/No of Wires (3ph/3wires)	Ph/Wires	
12.	Frame Size		
13.	Admissible Voltage Variation	%	
14.	Admissible Frequency Variation	%	
15.	Admissible Combined Volt. & Freq. Variation	%	
16.	Nominal Current (Average)	A	
17.	Starting Current	A	
18.	Full Load Speed	RPM	
19.	Insulation Class		
20.	Power Factor (Average Load)		
21.	Average Load Efficiency	%	
22.	Temp. Rise Over Ambient Temp. of 50°	°C	

Clause No.

ELECTRICAL ACTUATOR



.....
(Bidder's Name)

SI.No.	Description	Unit	Data
23.	Cable Gland Size/No: Power (Double Compression Cable Gland)		
24.	Cable Gland Size/No: Control (Double Compression Cable Gland)		
25.	Gear Box Lubrication		
26.	Position Limit Switches		
	(a) Quantity	Nos.	
	(b) No. of Contacts	Nos.	
27.	Torque Switches		
	(a) Quantity	Nos.	
	(b) No. of Contacts	Nos.	
28.	Voltage/Current Rating of Switches	V/A	
29.	Position Transmitter-ON/OFF Duty	Yes/No	
30.	Position Transmitter-Inching Duty (If provided)	Yes/No	
31.	Space Heater Power Supply Details		
32.	Cable size for Space Heater Terminal		
33.	Thermostat (One no. per phase)	3 Nos.	
34.	Internal Wiring Cable Size		
35.	Control Circuit Diagram (Enclosed)	Yes/No	
36.	Integral Starter Provided	Yes/No	
37.	Weight-Actuator	Kg	
38.	Motor Suitable for ON-OFF/Inching		

Clause No.


ELECTRICALACTUATOR




.....
(Bidder's Name)


SI.No.	Description	Unit	Data
39.	Motor Type & Ref. Stanard		
40.	OLR Set Value (Recommended)	A	
41.	Plug & Socket (Integral mounted on the Actuator)		
42.	The Colour Coding of Cables For 9 Pin Plug & Socket Suitable For 4 Pair, 0.5 SQMM Copper Cables		
43.	Single Phase Sequence Protection Provided	Yes/No	
44.	Wrong Phase Sequence Protection Provided	Yes/No	
45.	Paint Shade		
46.	Secondary Gear Box Gear Box Model & Ratio Gear Box Make Travel Time Secondary Gear Box Maximum Output Torque Type of Enclosure	 Secs Kgm	


MOTORS


Clause No.	LIGHTING (H ₂ GENERATION PLANT)		
1.00.00	<p style="text-align: right;">..... (Bidder's Name)</p> <p>LIGHTING</p> <p>Lighting Panel</p> <p>(a) Make (Shall be as per approved QA make)</p> <p>(b) Applicable standard (c) Enclosure (d) Catalogue attached as annexure no.</p>		
2.00.00	<p>Miniature Circuit Breaker</p> <p>(a) Make (b) Type designation (c) Applicable standard (d) Rated current & voltage (e) Breaking capacity at 0.6 p.f. (f) Catalogue attached as annexure no.</p>		
3.00.00	<p>Isolator</p> <p>(a) Make (b) Type designation</p>		
4.00.00	<p>Fuses</p> <p>(a) Make (b) Type (c) Applicable Standard</p>		
5.00.00	<p>Contactor</p> <p>(a) Make (b) Type & duty (c) Applicable Standard</p>		


ELECTRIC ACTUATOR


CLAUSE NO.	BIDDER'S NAME	
1.00.00	<p style="text-align: center;">LT SWITCHGEARS & LT BUSDUCTS</p> <p>SWITCHGEAR & MCC</p> <p>a) General</p> <p> i) Manufacturer's Name</p> <p> (Shall be as per approved QA make)</p> <p> ii) Type designation</p> <p> iii) Country of origin</p> <p>b) Rated voltage</p> <p>c) Symmetrical short circuit withstand current at rated voltage of switchgear /MCC cubicle.</p> <p>d) Peak short circuit withstand current</p> <p>e) Rated current at ambient</p> <p>f) Degree of protection as per IS:13947</p> <p> i) Breaker / MCC cubicles</p> <p> ii) Busbar chamber</p> <p>g) Cubicle sheet metal details</p> <p> i) Cold rolled / hot rolled</p> <p> ii) Thickness, structural & load bearing members</p> <p> iii) Thickness, front & rear</p> <p> iv) Thickness, Sides & top</p> <p> v) Thickness of gland plates</p> <p>h) Painting shade & Thickness as per IS :5</p> <p> i) External surfaces(front & rear)</p> <p> ii) Extreme end covers</p>	


CLAUSE NO.	BIDDER'S NAME	
2.00.00	i) Minimum Clearance in air for Busbars	
	i) Between phases	.....
	ii) Between phase & earth	.....
	j) Standard height, width & depth of typical panel	
	i) Circuit breaker panel	.....
	ii) MCC panels (S.F./D.F.)	.....
	iii) Circuit breaker panel with Bus trunking /Bus Duct Termination	.....
	iv) ACDB/DCDB	.....
	v) AC/DC Fuse boards	.....
	k) Width of cable alley	.....
	l) Shrouding arrangement in cable alley provided or not	YES/NO
	m) Earth busbar size & material	.....
	n) Approx. Weight of one panel With circuit breaker	.....
	o) Recommended dynamic loading for foundation design	.....
	p) Approx. weight of one MCC panel	.....


CLAUSE NO.	BIDDER'S NAME	
<p>3.00.00</p>	<p>CONTROL SUPPLY TRANSFORMER</p> <p>a) Make</p> <p>b) Type</p> <p>c) Material & class of insulation</p> <p>d) Voltage rating & taps</p> <p>e) Continuous rating (VA)</p>	
<p>4.00.00</p>	<p>CIRCUIT BREAKER</p> <p>a) Manufacturer's name and country of manufacturer</p> <p>b) Manufacture's type and designation</p> <p>c) Rated Voltage</p> <p>d) Rated operating duty</p> <p>e) Design ambient temperature</p> <p>f) Rated current at design ambient temperature</p> <p>g) Derating factor for site operating conditions inside panel</p> <p>h) Continuous current at ambient temp.</p> <p>i) Rated symmetrical breaking current</p> <p>j) Rated peak making current</p> <p>k) Rated short time rating (for 1 sec.)</p> <p>l) Rated peak momentary rating</p> <p>m) Number of openings, the circuit breaker is capable of performing without inspection, replacement of contacts or other parts at 100% rated breaking current</p> <p>n) No. of breaker auxiliary contacts provided on fixed portion of breaker & their rating</p>	


CLAUSE NO.	BIDDER'S NAME	
	<p>o) Trip free and anti pumping features have been provided (Furnish description) YES/NO</p> <p>p) Power operating mechanism</p> <p>q) Spring charging motor details</p> <p> i) Type</p> <p> ii) Rating Watts</p> <p> iii) Rated voltage</p> <p> iv) Class of insulation</p> <p> v) Time for fully charging the closing spring</p> <p>r) Emergency Manual charging facility provided YES/NO</p> <p>s) Limits of voltage for satisfactory operation of the following devices as percentage of normal voltage</p> <p> i) Motor</p> <p> ii) Closing coil</p> <p> iii) Tripping coil</p> <p>t) Manual operating mechanism</p> <p>u) i) Type of Releases provided</p> <p> ii) Available range of following parameters for each type of release offered</p> <p>v) i) Maximum Tripping Time</p> <p> ii) Maximum Closing time</p> <p>w) i) Closing coil VA</p> <p> ii) Tripping coil VA</p> <p>x) Telescopic trolley</p> <p> i) Make</p>	


CLAUSE NO.	BIDDER'S NAME	
5.00.00	<p>ii) Type designation</p> <p>iii) Dimensions</p> <p>AIR BREAK SWITCHES</p> <p>(The following details shall be furnished for each type & rating)</p> <p>a) Make</p> <p>b) Type</p> <p>c) Applicable standards</p> <p>d) Rated current at design ambient temperature (Amps)</p> <p>e) Design ambient temperature Deg C</p> <p>f) Rated breaking current (kA)</p> <p>g) Maximum through fault current withstand kA</p> <p>h) Door interlock as specified has been provided ? YES/NO</p> <p>i) No. of auxiliary contacts and its rating</p>	
6.00.00	<p>CONTROL/SELECTOR SWITCH</p> <p>a) Make</p> <p>b) Type Designation</p> <p>c) Voltage grade</p>	
7.00.00	<p>CONTACTOR</p> <p>(The following details shall be furnished for each type and rating)</p> <p>a) Make</p> <p>b) Type & applicable standards</p> <p>c) Rated voltage of main and auxiliary contacts</p> <p>d) Rated voltage of coils</p>	


CLAUSE NO.	BIDDER'S NAME	
	e) Limits of operation i) Supply voltage variation +/--% ii) Supply frequency variation for closing (+/-)% iii) Drop out voltage % f) Rated (thermal) current A g) Rated duty h) Rated utilisation category as per IS:13947 i) Rated breaking capacity kA j) Rated making capacity - kA k) Coil VA burden	
8.00.00	AUXILIARY CONTACTOR a) Make b) Type c) Catalogue attached as Annexure No.	
9.00.00	FUSES a) Make b) Type c) Category	
10.00.00	CURRENT TRANSFORMERS (The following details shall be provided for each type & rating) a) Make b) Applicable standards c) Ratio d) VA Rating	

CLAUSE NO.	BIDDER'S NAME	
11.00.00	<p>e) Accuracy class</p> <p>f) Class & type of insulation</p> <p>VOLTAGE TRANSFORMERS</p> <p>a) Make</p> <p>b) Ratio</p> <p>c) VA Rating</p> <p>d) Accuracy class</p> <p>e) Over voltage factor</p> <p>f) Class & type of insulation</p>	
12.00.00	<p>Numerical relays(If applicable)</p> <p>a) General Technical Details and Drawings Enclosed</p> <p>b) Make/Model No</p> <p>c) Place of Manufacture</p> <p>d) Hardware version number</p> <p>e) Firmware version number</p> <p>f) Rated Voltage Vn (phase-to-neutral)</p> <p>g) Rated Current In</p> <p>h) Rated Frequency</p> <p>i) Over voltage capability - continuous</p> <p>j) Over voltage capability – 3s</p> <p>k) Burden on voltage transformers (VA per phase)</p> <p>l) Over current capability - continuous</p> <p>m) Over current capability – 1s</p> <p>n) Burden on current transformers (VA per phase)</p>	

CLAUSE NO.	BIDDER'S NAME	
	<ul style="list-style-type: none"> o) Reference standards p) Operating principle q) No Of communication Ports r) Compliance to IEC-61850 s) Built-in functions provided in the relay (list out) t) Protection Functions u) Measurements v) Monitoring Functions w) Control functions x) Detailed Technical Catalogue for offered Relays enclosed y) Spares and Repairs <ul style="list-style-type: none"> a) State availability of spares in country and spares holding in country of origin b) Maximum repair turnaround time c) Define the proposed repair strategy d) Recommended spares list z) List of reference sites in operation for more than 1 year 	
13.00.00	<p>THERMAL OVERLOAD RELAY & SINGLE PHASING PREVENTER</p> <p>(The following details shall be furnished for each type & rating)</p> <ul style="list-style-type: none"> a) Make & type designation b) Catalogue 	
14.00.00	<p>VOLTMETER</p> <ul style="list-style-type: none"> a) Make b) Type 	

CLAUSE NO.	BIDDER'S NAME	
15.00.00	c) Catalogue AMMETER	
16.00.00	a) Make b) Type c) Catalogue PUSH BUTTONS	
17.00.00	a) Make b) Type designation c) Catalogue INDICATING LAMPS	
18.00.00	a) Make b) Type c) Catalogue LOCAL STARTERS	
19.00.00	a) Make & Type b) Catalogue 415 V NON SEGREGATED BUSDUCTS(If applicable) a) Manufacturer's name & address b) Type of busduct c) Material and cross section of busbars d) Rated voltage (volts) e) Maximum voltage at which busduct can operate continuously (volts) f) Continuous current rating of busbars (Amps) g) Short circuit current ratings & duration (kA /Sec)	

CLAUSE NO.	BIDDER'S NAME	
	<ul style="list-style-type: none"> h) Momentary current rating kA peak i) Temperature rise over the ambient temperature <li style="padding-left: 20px;">i) Busbars <li style="padding-left: 20px;">ii) Enclosures j) Material of support insulator k) No. and arrangement of support insulators l) Material of Gaskets m) One minute power frequency withstand voltage (kV) n) Minimum creepage distance over insulator (mm) o) Conductor treatment p) Clearance (mm) <li style="padding-left: 20px;">i) Phase to Phase <li style="padding-left: 20px;">ii) Phase to earth q) Average weight per meter of busduct (kg) r) Material and thickness of Busduct s) Shape & size of enclosure 	
20.00.00	<p data-bbox="440 1283 919 1310">LIGHTING / WELDING TRANSFORMERS</p> <ul style="list-style-type: none"> a) Make b) Voltage Ratio c) kVA Rating d) Vector Group e) Type of Cooling f) Percentage impedance g) Details of taps provided 	

CLAUSE NO.	BIDDER'S NAME	
21.00.00	<p>h) Class of insulation</p> <p>i) Degree of protection for enclosure</p> <p>j) Whether mounted inside MLDB or outside</p> <p>k) If it is mounted outside dimension of the enclosure</p> <p>Metering Network and Energy Meters (For Motor>& = 100 KW)(If applicable)</p> <p>a) Energy Meters</p> <p>i. Manufacturer's type designation</p> <p>ii. Accuracy (Power and Energy)</p> <p>iii. Input Voltage</p> <p>iv. Input current</p> <p>v. Mounting</p> <p>vi. Communication (in Built 485 Port)</p> <p>vii. Data recorded in Non-volatile memory</p> <p>viii. Burden</p> <p>b) Type designation of RS 485 Converter</p> <p>c) Type designation of LAN cable</p> <p>d) Type Designation of Data Cable</p>	
22.00.00	<p>Ethernet switches (For Networking of Numerical Relays)(If applicable)</p> <p>a) Compliance to IEC 61850</p> <p>b) No of Ports</p> <p>c) Power supply to Ethernet Switches</p>	



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	

**SECTION C-2
SPECIFIC TECHNICAL REQUIREMENTS
(ELECTRICAL)**



ELECTRICAL EQUIPMENT SPECIFICATION
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I

SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	

1. 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) Erection and Commissioning spares.
- e) Erection & Maintenance tools & tackles.
- f) Electrical load requirement for Hydrogen generation plant.
- g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- h) 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.
- i) 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.

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

Refer “Electrical Scope between BHEL and Vendor”.

3. DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with this two signed and stamped copies of the following shall be furnished by the bidder as technical offer:

- a) A copy of this sheet “Electrical equipment Specification for “Hydrogen generation plant” and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp.
- b) List of Erection and Commissioning spares.
- c) List of Erection & Maintenance tools & tackles.
- d) Electrical load requirement

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
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SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	

**ANNEXURE 4
ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR**

**STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE : HYDROGEN GENERATION PLANT**

PROJECT : 2 X 800MW GADARWARA STPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Vendor	Vendor	1. 415 V AC/240 V AC 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 including power supply equipment (battery charger etc) required for the PLC/control panel (as applicable) for the system supplied by vendor. 2. Interposing relays (RE 302 of Jyoti make or equivalent), if required for PLC and microprocessor based systems, shall be provided by BHEL in MCCs. Requirement of these relays shall be furnished by vendor during detailed engineering stage.
2	Local Push Button Station (for motors)	Vendor	Vendor	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	Vendor Vendor Vendor	Vendor Vendor Vendor	1. Sizes and quantity of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL). Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by vendor. 3. Termination at BHEL equipment terminals by BHEL. 4. Termination at Vendor equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	Applicable within the plant boundary
5	Cable trays, accessories & cable trays supporting system	Vendor	Vendor	
6	Cable glands and lugs for equipments 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 cables 3. Solder less crimping type heavy duty copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer/ BHEL approval at contract stage.
8	Lighting	Vendor	Vendor	
9	Equipment grounding & lightning protection	Vendor	Vendor	
10	Below grade grounding	Customer	Customer	
11	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.

**STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE : HYDROGEN GENERATION PLANT**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
12	Mandatory spares	Vendor	-	Vendor to quote as per specification.
13	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
14	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies in the BHEL cable schedule format.
16	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Electrical equipment layout drawing shall be to BHEL approval.
17	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/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.



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
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**ANNEXURE 5
ELECTRICAL LOAD FORMAT**




**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**


SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	


SECTION – D1


**DESIGN REQUIREMENTS
MECHANICAL**


NOTE: Some of the design requirement specified in section D1 may not be relevant to the bidder design. Only the requirements relevant for bidder's system shall be considered by the bidder.


CLAUSE NO.	TECHNICAL REQUIREMENTS	
HYDROGEN GENERATION PLANT		
1.00.00	GENERAL PLANT DESIGN CRITERIA	
1.01.00	To be designed for continuous, as well for as two shift or one shift operation.	
1.02.00	The scheme shall be based on manufacturer's standard. The scheme & construction details of equipment are described for hydrogen generation plant of unipolar design in this section. However, Bipolar designs are also acceptable, provided the same are of proven design from reputed manufacturers. 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. However, for such bipolar design, all safety measures shall be provided in line with specification/ schematic drawing.	
1.03.00	Total Plant Capacity to be sized as follows :	
1.03.01	Leakage rate per generator = "A" NM ³ /day	
1.03.02	Requirement of one generator filling = "B" NM ³ .	
1.03.03	Number of TG Units = C	
1.03.04	Hydrogen generation plant Capacity = [C*1.5* A + B/30]/12 NM ³ /hr	
1.03.05	However total plant capacity shall not be less than 20 NM ³ /hr with two streams of 50% Capacity each of minimum 10 NM ³ /hr.	
1.04.00	Hydrogen purity to be maintained at gas manifolds 99.9%.	
1.05.00	Moisture content in hydrogen :- 0.05 gm/m ³ (max.)	
1.06.00	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.	
2.00.00	GENERAL OPERATIONAL CRITERIA/PHILOSOPHY	
2.01.00	To be designed for Continuous duty.	
2.02.00	To be designed for parallel operation of both streams.	
2.03.00	Flexibility to operate electrolyser in part load.	


CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.04.00	Complete operation from remote control panel/OWS.			
2.05.00	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.			
2.06.00	Set pressure to be maintained with help of back pressure regulation valve.			
2.07.00	Automatic operation of standby compressor as and when required.			
2.08.00	To provide alarm & tripping of compressor based on suction conditions.			
3.00.00	CONSTRUCTION DETAILS OF EQUIPMENT			
3.01.00	Electrolyser			
3.01.01	Modular type. Both bipolar and unipolar type of electrolysers are acceptable.			
3.01.02	Cells in electrolyser 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 shall be of corrosion resistant material.			
3.01.03	The electrolyser 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.			
3.01.04	All measuring instruments, controllers and control valves shall be provided.			
3.01.05	Safety devices are to be provided on each collecting pipe to release gas pressure in case it goes above the limits.			
3.01.06	To be designed so that it can be dismantled, cleaned, and reassembled easily.			
3.01.07	Proper sealing shall be provided by the Bidder while crossing the wall to avoid any gas leakage to Rectifier Room.			
3.01.08	<p>Each electrolyser shall be fitted with the following instrumentation.</p> <p>(a) 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.</p> <p>(b) A local pneumatic temperature controller, controlled through PLC, to maintain the electrolyser temperature to a preset value by controlling cooling water flow to the electrolyser through the temperature control valve.</p>			

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	(c) One temperature gauge for local indication for electrolyte temperature. (d) One off-line specific gravity measuring instrument.		
3.02.00	Rectifier		
3.02.01	Two nos, of rectifier (one for each electrolyser) to cater 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.		
3.03.00	Gas washing Tanks (if applicable)		
3.03.01	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.		
3.04.00	Demineralised water tank		
3.04.01	One number tank of Capacity adequate for 5 days normal requirement of hydrogen gas generation on continuous basis at rated capacity of (minimum) 20 NM ³ /hr.		
3.04.02	To be fitted with removable drain connections, level switches/ transmitters, level indicators etc.		
3.05.00	Caustic solution mixing tank (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.		
3.06.00	Hydrogen gas Holders (if applicable) (i) Number Two (2) numbers (one for filling, one for supply to compressor) (ii) Capacity Each Gas holder shall be equal to that of hydrogen generation plant capacity or minimum of 20 NM ³ /hr (whichever is higher).		

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	(iii) Material (iv) To be designed for outdoor duty (v) To provided with two (2) Seal pots for each gas holders (vi) Accessories such as Wire rope, Counter weight, guide pulley required to suspend the gas holders, steel stairs four-way motorised 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.	IS-2062/2002 or equivalent	
3.07.00	De-oxy unit (if applicable)		
3.07.01	One number De-Oxy unit shall be provided to handle both the streams and capable to remove oxygen as impurity. The unit should have accessories such as heater with temperature control device, gas cooler, filter, necessary instruments etc		
3.08.00	Hydrogen compressors and drives,		
	(i) Number	3x50% as specified in the scope (two working & one standby)	
	(ii) Capacity of each compressor shall be	125% of each stream capacity	
	(iii) Design delivery Pressure	150 kg/cm ² (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.	
	(vii) Drive cage	As speciifed in relevant subsections (Electrical) of Technical Speciifcations.	
	(viii) Activated carbon filters	2 x100% and required in case of oil lubricated compressor	
	(ix) All metal to metal joints shall be provided with "O" rings of suitable grade material.		

CLAUSE NO.	TECHNICAL REQUIREMENTS	
	<p>(x) 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 analyser at the suction etc.</p> <p>(xi) 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.</p>	
3.09.00	Drying system for Hydrogen gas	
3.09.01	To provide twin tower Moisture separating columns of Regenerative design alongwith instruments.	
3.09.02	To provide valves arrangement to suit operation of one Column & another under regeneration. The operation shall be automatic based on PLC/microprocessor command.	
3.10.00	Back Pressure regulating valve	
3.10.01	Spring loaded disc operated self actuating type back pressure regulating valve to maintain 150 kg/cm ² (g) pressure on the compressor discharge.	
3.10.02	To be provided with accessories such as Pressure sensing element, controller etc.	
3.11.00	Cylinder Manifold	
3.11.01	To provide one dual cylinder filling manifold, arranged for two banks of minimum four cylinders each.	
3.11.02	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 analyser, moisture analyser at cylinder manifold, records of hydrogen purity and moisture content, & one number PORTABLE hydrogen gas purity testing kit.	

CLAUSE NO.	TECHNICAL REQUIREMENTS		
3.12.00	Flushing System		
3.12.01	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.		
3.13.00	Piping		
3.13.01	All Pipe to conform to ASA pressure piping code, and seam less type.		
3.13.02	All high pressure joints shall of ferrule/ welded construction.		
3.13.03	All vents to be fitted with flame arrestor.		
3.13.04	All high pressure drains to be terminated through H2 traps and all low pressure drains to be terminated through U-bends.		
3.13.05	Cooling water pipe be minimum 80 NB size.		
4.00.00	VENTILATION SYSTEM		
4.01.00	It shall consist of adequate number of roof exhausters, wall mounted exhaust fans, ducting (if required), drives & other electrical accessories ducting supports and supporting system, rain protection cowl, bird screens, vibration isolators nuts & bolts, grouting frame, transition piece etc. as required to complete the system.		
4.02.00	The air quantity of ventilation system shall be estimated based on equipment and solar heat load and the temperature rise inside the building shall be restricted to maximum of 3 deg.C over design ambient. However, in no case the number of air changes shall be less than 30 air changes per hour. The exhaust air shall be discharged at a suitable height from the room.		
4.03.00	Bidder to provide louvers for fresh air supply the building layout.		
4.04.00	Bifurcated type of axial flow fans for exhausting air/fumes shall be provided for hydrogen generation plant area and shall be of flame proof construction with inlet and outlet dampers. However, ducts and all other parts like blades etc. shall be epoxy painted.		
5.00.00	HYDROGEN AND CO₂ GAS CYLINDERS		
5.01.00	Adequate quantity of gas cylinders shall be supplied and installed as described in relevant Electrical Sub-Sections of technical specification.		

CLAUSE NO.	TECHNICAL REQUIREMENTS	
6.00.00	CONTROL AND INSTRUMENTATION	
6.01.00	<p>All electrical devices like switches/transmitters/controller/analyzer/solenoid valves which are located in the hydrogen generation plant shall be made intrinsically safe by providing suitable type of transformer isolated barrier/ Zenner barrier of standard make. Otherwise such instruments shall be provided with explosion proof enclosure suitable for hazardous areas describd in National Electric Code (USA), Article 500, Class-I, Division-I or EN60079-14 or shall comply with the essential requirements of ATEX directives. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.</p>	
7.00.00	PAINTING	
7.01.00	<p>All the Piping, Valves and Equipments of this system shall be protected against external corrosion by providing suitable painting.</p>	
7.02.00	<p>The surfaces of stainless steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting.</p>	
7.03.00	<p>The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shotblasting etc as per the agreed procedure.</p>	
7.04.00	<p>For all the steel surfaces, one primer coat of epoxy resin based zinc phosphate primer of having a minimum DFT of 100 microns followed up with undercoat of epoxy resin based paint pigmented Titanium di-oxide with minimum DFT of 100 microns shall be applied. Thereafter topcoat shall be applied consisting of one coat of epoxy paint suitably pigmented of approved shade with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT 25 microns shall be provided over the topcoat.</p> <p>The paint may be applied in one coat, incase of high built paint is used, otherwise two coats shall be applied. Total DFT shall not be less than 300 microns.</p>	
7.05.00	<p>Painting of imported items shall however be as per manufacturer's standard practice.</p>	



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO.PE-TS-394-168-A001

VOLUME-IIB

SECTION

REV.NO.0

DATE

SHEET

LOW PRESSURE PIPING SYSTEM

LOW PRESSURE PIPING

1.00.00

EQUIPMENT SIZING CRITERIA

1.01.00

All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

1.02.00

For all L.P. 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.

1.03.00

Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following:

a) **Water Application**

	Pipe Size	Water Velocity in m/sec		
		Below 50 mm	50-150 mm	200 mm & above
(a)	Pump suction	-----	1.2-1.5	1.2-1.8
(b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5
(c)	Header	-----	1.5-2.4	2.1-2.4

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

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

(i)	Carbon steel pipe	100
(ii)	C.I Pipe/ Ductile Iron.	100
(iii)	Rubber lined steel pipe	120
(iv)	Stainless steel pipe	100

	<p>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.</p> <p>(b) Compressed Air Application</p> <p>Compressed air 15.0 m/sec.(under Average Pressure & Temp. conditions)</p>
1.04.00	The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
1.05.00	Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
1.06.00	Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
1.07.00	Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
1.08.00	High points in piping system shall be provided with vents along with valves as per the system requirement. Low points shall be provided with drains along with drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
1.09.00	Material of construction for pipes carrying various fluids shall be as specified elsewhere.
1.10.00	Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
1.11.00	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
1.12.00	Threaded joints shall be provided with Teflon sealant tapes.
1.13.00	Following types of valves shall be used for the system/service indicated.

	SYSTEM	TYPES OF VALVES					
		Butterfly	Gate	Globe	Check	Ball	Plug
	Water	x	x	x	x	x	
	Air		x	x	x	x	
	Drains & vents		x	x	x		
	Fuel oil (if any)		x	x	x	x	x
1.14.00	Recirculation pipes along with valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (p&ids). The recirculation pipe shall be sized for minimum 30% design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.						
2.00.00	TECHNICAL SPECIFICATION						
2.01.00	GENERAL						
	Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers / supports, tanks etc.						
2.02.00	Pipes and fittings						
2.02.01	All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness as specified in the following clauses and or respective codes for pipes and fittings shall be adhered to. The bidder shall furnish the pipe sizing/thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.						
2.02.02	Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.						
2.02.03	Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during						

	<p>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.</p> <p>2.02.04 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).</p> <p>2.02.05 Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.</p> <p>2.02.06 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/ expansion joint etc. shall be provided as may be necessary depending on layout.</p> <p>2.02.07 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.</p> <p>2.02.08 For rubber lined ERW pipes, beads shall be removed.</p> <p>2.02.09 Inspection holes shall be provided at suitable locations for pipes 800 Nb and above as required for periodic observations and inspection purposes.</p> <p>2.02.10 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.</p> <p>2.02.11 For large size pipes/ducts, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.</p> <p>Transient analysis /surge analysis where ever specified and required shall be conducted in order to determine the location , number and size of the Air-Release valve on certain long distance/high volume piping systems, if applicable within the scope of work of the package.</p>
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2.03.00

Material

2.03.01

Alternate materials offered by Bidder against those specified. shall either be equal to or superior to those specified, The responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.

2.03.02

No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.

2.03.03

All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockists are not acceptable.

2.03.04

All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable references to enable identification of the certificate that certifies the material.

2.03.05

Material of construction for pipes carrying various fluids shall be as follows:

SI No.	Type of Fluid	Material
1.	<ul style="list-style-type: none"> i) Ordinary Water (Raw Water, Clarified Water, CW blow down water etc.) ii) Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW drain water) 	IS-2062 Gr.-B/ASTM A-36/ASTM A-53 type 'E'Gr.B/IS-3589 Gr. 410 /IS-1239 Heavy.
2.	<ul style="list-style-type: none"> i) Demineralised water, ii) Alkaline solution (ECW system chemical dosing) iii) Equipment cooling water piping from overhead tank to suction header of DMCW pumps. 	<p>Stainless Steel to ASTM A312, Gr. 304 welded for sizes 65 mm NB and above.</p> <p>Stainless steel to ASTM A312, Gr. 304 sch.40s seamless for sizes 50mm and below</p>
3.	<ul style="list-style-type: none"> i) Drinking (potable) water ii) Compressed air (Instrument & service air) 	ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.
4.	(Condensate) spill water	ASTM A 106 Gr. B

2.03.06	In water lines, pipes upto 150mm Nb shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr.B /IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS:1239 Grade Heavy except for demineralised water, drinking water and condensate spill lines.
2.03.07	Pipes of above 150mm Nb shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr.410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr.B/ASTM-A-36. However, larger pipes, i.e. 1000mm Nb and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr.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).
2.03.08	<p>In demineralised water service, the pipes upto 50 Nb shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.</p> <p>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.</p>
2.03.09	Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410 / IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B / IS: 3589, Gr. 410 / IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).
2.03.10	Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
2.03.11	Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
2.03.12	If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.

2.04.00	Piping layout
2.04.01	Piping shall be grouped together where practicable and routed to present a neat appearance.
2.04.02	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.
2.04.03	Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8m above roadways/railways. When several pipe lines 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.
2.04.04	Pipe lines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipes and submit to Employer for approval.
2.04.05	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. Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
2.04.06	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.
2.04.07	Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.
2.04.08	All local instruments shall be located on pipe lines as to render them observable from the nearest available platforms.
2.04.09	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

2.05.00	<p>and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.</p> <p>Slope/Drains and Vents</p>
2.05.01	<p>Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vent shall not be less than 15mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15mm for line size up to 150mm, not less than 20mm up to 300mm and not less than 25mm for 350mm to 600mm pipes and not less than 50mm for 600mm and above pipes.</p>
2.05.02	<p>Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.</p>
2.06.00	<p>Pipe Joints</p> <p>In general all water lines 65mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.</p>
2.06.01	<p>Screwed</p> <p>(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.</p> <p>(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</p>

ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, along with the nascent threaded metal portions at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

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

2.06.02

Welded

- (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.

<p>2.06.03</p>	<p>Flanged</p> <p>(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.</p> <p>(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.</p> <p>(c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.</p>
<p>2.07.00</p>	<p>Bends/elbows/mitre bends/ Tees/ Reducers & other fittings</p>
<p>2.07.01</p>	<p>For pipe fittings such as elbows (long radius), reducers, tees, etc. the material shall be to ASTM-A-234 Gr. WPB/ASTM-105 up to 300 NB. For pipe fittings above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fitting shall conform to the dimensional standard of ANSI B-16.9/ 16.11. Further branching in pipes for sizes 65nb and above is also acceptable (ANSI B 31.1).</p> <p>However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.</p>
<p>2.07.02</p>	<p>For pipe size 350Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.</p>
<p>2.07.03</p>	<p>For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.</p>
<p>2.07.04</p>	<p>Stainless steel fittings shall conform to either ASTM-A-182 Gr. 304 or ASTM-A-403 Grade WP. 304 Class-S, for sizes upto and including 50 mm NB, i.e. the fittings shall be of seamless construction. However, for stainless fittings above 50 mm NB, the same shall conform to ASTM-A-403 Gr. WP 304 Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.</p>
<p>2.07.07</p>	<p>In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.</p>

2.08.00	Flanges
2.08.01	Flanges shall be slip on type. Welding of flanges in tension is not permitted.,
2.08.02	All flanges and-flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. 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.
2.09.00	Specific technical requirement of laying buried pipe with anti corrosive treatment The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.
2.09.01	Trenching (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822. (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 1000mm 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
2.09.02	Preparation and cleaning of piping (a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand 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.

<p>2.09.03</p>	<p>(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.</p> <p>(c) 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 230mm for joints, which shall be coated manually at site after laying, welding and testing the pipe.</p> <p>(d) 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.</p> <p>Coating and wrapping</p> <p>(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:</p> <ol style="list-style-type: none"> (1) Coating primer (coal tar primer) (2) Coating enamel (coal tar enamel) (3) Wrapping materials. <p>(b) 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.</p> <p>(c) 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</p> <p>(d) 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.</p> <p>(e) Total thickness of completed coating shall not be less than 4.0 mm.</p> <p>(f) Alternatively, the anti-corrosive protection 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</p>
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	<p>tar primer preferably in steps of 2mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm minimum.</p>
2.09.04	<p>Trench bed preparation and back filling</p> <p>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.</p>
2.09.05	<p>Laying of galvanized steel (GI) pipes</p> <p>All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joint shall be applied with Zinc silicate paste.</p> <p>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.</p>
2.10.00	<p>Cleaning and flushing</p>
2.10.01	<p>All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.</p>
2.10.02	<p>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.</p>
2.10.03	<p>After erection, all water lines shall be mass flushed with water. The cleaning velocities in water lines shall be 1.2-1.5 times the operating velocities in the pipelines.</p>
2.10.04	<p>All compressed air pipe work shall be cleaned by blowing compressed air.</p>
2.11.00	<p>Surface preparation and painting</p> <p>Pipes shall be cleaned both internally and externally thoroughly by blast-cleaning or power tool cleaning method as indicated above.. In case of oil piping, cleaning will have to be done by pickling. No painting is required on stainless steel pipe /</p>

<p>2.11.01</p>	<p>equipment surface, galvanized pipe surface or galvanized steel surface. However, necessary color banding for identification as per color code shall be done. External surface of piping shall be cleaned and prepared as indicated below.</p> <p>Primer painting</p> <p>(a) After the surface is prepared two coats of red oxide (zinc chromate/zinc phosphate) primer conforming to IS-2074/IS-12744 or equivalent shall be applied. Primer coat shall be immediately applied without any time lag after the surface preparation.</p> <p>(b) Any equipment which has been given the shop coat of primer shall be carefully examined after its erection in the field and shall be treated with a touch up coat of primer wherever the shop coat has been abraded, removed or damaged during transit/erection, or defaced during welding.</p>
<p>2.11.02</p>	<p>Finish painting</p> <p>(a) Paint to be used shall be synthetic enamel paint conforming to IS-2932 or equivalent. Finish painting shall be carried out in three coats consisting of one intermediate coat and two finishing coats. Dry film thickness (DFT) of painting inclusive of primer thickness shall be at least 150 micron.</p> <p>(b) The primed surface shall be cleaned of dust/dirt/grease etc. without scratching or in any way damaging the primer coat. The intermediate coat shall be allowed to dry before applying the finish coat or as recommended by paint manufacturer.</p> <p>(c) Paint shall be applied by brushing. It shall be ensured that brush marks are a minimum and the requirements of workmanship is as specified in IS-1477.</p> <p>(d) Paint used shall be stirred frequently to keep the pigment in suspension. Paint shall be of the ready mix type in original sealed containers as packed by the paint manufacturer. No thinners shall be permitted.</p> <p>(e) No painting shall be done in frost/foggy weather or when the humidity is high to cause-condensation on the surface to be painted.</p> <p>(f) The dry film thickness (DFT) after the painting shall not be less than 150 microns.</p>
<p>2.11.03</p>	<p>Other requirements</p> <p>(a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.</p>

	<p>(b) The color of the finish paint shall be as per approved color-coding.</p> <p>(c) If finish paint was applied in shop, one coat of finish paint shall be applied at site.</p> <p>(d) The dry film thickness of paint shall not be less than 0.15 mm.</p>
2.11.04	<p>Color code for identification</p> <p>The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.</p>
2.12.00	Specification for hangers and supports
2.12.01	All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.
2.12.02	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.
2.12.03	Hanger for piping 65mm 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.
2.12.04	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 pipe line 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.
2.12.05	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.
2.12.06	The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.
2.12.07	All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
2.12.08	At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.
2.12.09	All components of hangers/supports 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

2.13.00	<p>& 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.</p> <p>Design/Construction/Material Particulars of Gate/ Globe/Check Valves/ Globe Stop Valve/Butterfly valve</p>
2.13.01	<p>GENERAL</p> <ul style="list-style-type: none"> (a) All valves shall be suitable for the service conditions i.e flow, temperature and pressure, at which they are required to operate. (b) The valves as well as all accessories shall be designed for easy disassembly and maintenance. (c) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion. (d) 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. (e) 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. (f) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined. (g) 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 350mm and above either bevel or spur gearing shall be provided to facilitate manual operation. (h) The valves coming in vacuum lines shall be of extended gland type and/or water sealed. (i) The actuator-operated valves shall be designed on the basis of the following: <ul style="list-style-type: none"> (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.

	<p>(3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.</p> <p>(4) All actuators operated valves shall open/ close fully within time required by the process.</p> <p>(j) Valves coming under the purview of IBR shall meet IBR requirements.</p> <p>(k) Gate/slucice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:</p> <p>(1) Hand wheel</p> <p>(2) Position indicator (for above 50 mm NB valve size)</p> <p>(3) Draining arrangement wherever required.</p> <p>(l) 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.</p> <p>(m) Check valves shall be used for non-return service. They shall be swing. check type or double door (Dual plate)check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening /closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600mm NB</p> <p>(n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.</p> <p>(o) 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.</p> <p>(p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.</p> <p>(q) 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.</p>
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<p>2.13.02</p> <p>2.13.03</p>	<p>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.</p> <p>(r) All valves except those with rising stems shall be provided with continuous mechanical position indicators; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.</p> <p>(s) 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.</p> <p>VALVE BODY MATERIAL</p> <p>Valve body material for various services shall be as follows:</p> <p>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 65NB and above; gun-metal for sizes 50 Nb and below.</p> <p>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.</p> <p>DM water: SS body and disc along with SS internals.</p> <p>Condensate: Cast Carbon Steel / Forged Carbon Steel.</p> <p>The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.</p> <p>Standards and Codes</p> <table border="0"> <tr> <td data-bbox="423 1602 602 1629">AWWA-C-504</td> <td data-bbox="786 1602 1166 1629">Rubber seated butterfly valves.</td> </tr> <tr> <td data-bbox="423 1671 638 1698">BS-5155/EN-593</td> <td data-bbox="786 1671 1458 1734">Cast iron and steel body butterfly valves for general purpose.</td> </tr> </table>	AWWA-C-504	Rubber seated butterfly valves.	BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
AWWA-C-504	Rubber seated butterfly valves.				
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.				

2.13.04	<p>IS-778 Gun-metal gate, globe and check valves for general purpose.</p> <p>BS-5154 Copper alloy globe/globe stop and check and gate valves for general purpose.</p> <p>IS-780 Sluice valves for water works purpose (50-300 mm size)</p> <p>IS-2906 Sluice valves for water works purpose (350-1200 mm size)</p> <p>IS-5150 Cast iron wedge and double disc gate for general purpose.</p> <p>BS-5152 Specification for cast iron globe valves.</p> <p>BS-5153 Cast iron check valves for general purpose.</p> <p>IS-5312 Swing check type reflux (non-return) valves.</p> <p>ANSI B 16.34 Standard for valves.</p> <p>API-594 Standard for Dual-check valves.</p> <p>API-600 Steel gate valves.</p> <p>ANSI-B-16.10 Valves face to face and other relevant dimension.</p> <p>API-598 Valves inspection test.</p> <p>End Connections</p> <p>The end connections, shall comply with the following:</p> <p>Socket welding (SW) - ANSI B 16.11</p> <p>Butt Welding (BW) - ANSI B 16.25.</p> <p>Threaded (SC) - ANSI B 2.1</p> <p>Flanged (FL) - ANSI B 16.5& AWWA-C-207(steel flanges), ANSI B 16.1 (Cast Iron flanges)</p>
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2.13.05	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).
2.13.06	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.
2.13.07	All gun metal body valves shall have screwed ends.
2.13.08	All flanged end valves/specialties. shall be furnished along with matching counter flanges, fasteners, gaskets etc. as required to complete the joints.
2.14.00	Check Valves
2.14.01	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.
2.14.02	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.
2.14.03	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.
2.14.04	Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.
2.15.00	Globe Valves
2.15.01	The globe valves shall have the following characteristics:
	Straight conveyed flow.
	Right angle
	Preferably, the valves shall be of the vertical stem type.

2.15.02	Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.
2.15.03	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.
2.15.04	For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.
2.15.05	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.
2.16.00	<p>Gate valves</p> <p>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.</p> <p>Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.</p>
2.17.00	<p>Air Release Valve</p> <p>(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.</p> <p>(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.</p> <p>(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.</p> <p>(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.</p>

2.18.00	Butterfly valves
2.18.01	<p data-bbox="423 275 699 306">Design/Construction</p> <p data-bbox="423 344 1463 621">(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.</p> <ol data-bbox="516 659 1463 1772" style="list-style-type: none"> <li data-bbox="516 659 1463 793">(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 <li data-bbox="516 835 1463 1037">(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. <li data-bbox="516 1079 1463 1281">(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. <li data-bbox="516 1323 1463 1600">(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. <li data-bbox="516 1642 1463 1772">(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 300mm or less shall be provided with handles for ease of operation.

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

Valves-200Nb and above shall also be provided with gear operator arrangement as a standard practice suitable for manual operation. Manual operation of valve shall be through gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

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

2.18.02

Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below :

(a) **Cast Iron Butterfly Valves**

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

- Shaft BS 970 431 S: 291 / EN 57, or
AISI-410 or AWWA-permitted shaft
material equivalent to EN-57/AISI-410 or better.

- Seat ring 18-8 Stainless steel

- Seal Nitrile Rubber

(b) **Stainless Steel Butterfly Valves**

- Body & Disc ASTM A 351, Gr. CF8M / ASTM-A-182-Gr.304.

- Shaft ASTM A 182, Gr. 316 / ASTM-A-479
Gr.316/Equivalent

- Disc & Seat Rings EPT/BUNA-N/Neoprene

(c) **Carbon steel Butterfly Valves**

- Body & Disc ASTM A 216, Gr. WCB

- Shaft ASTM A 182, Gr. 304 / ASTM-A-479
Gr.304/Equivalent

- Disc & Seat Rings EPT/BUNA-N/Neoprene

2.18.03

Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the

absence of which actual P.O.D. test shall be conducted by the bidder 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 P.O.D test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504.

2.19.00

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-479Gr.316 / ASTM A 351 Gr. CF 8M

(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

<p>2.20.00</p> <p>2.21.00</p>	<p>Stem for gate globe valves 13% chromium steel or Equivalent</p> <p>Back seat 13 % chromium steel / 13% Chrome overlay</p> <p>(4) Gun Metal valves</p> <p>Body and bonnet IS 318 Gr. 2/ Equivalent Standard</p> <p>Trim. -do-</p> <p>(b) Cast iron body valves shall have high alloy steel stem and seat.</p> <p>(c) Material for counter flanges shall be the same as for the piping.</p> <p>Float operated valves</p> <p>(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.</p> <p>(b) DESIGN AND CONSTRUCTION FEATURES</p> <p>The following design and construction feature of the valve shall be the minimum acceptable.</p> <p>(c) Valves shall be right-angled or globe pattern.</p> <p>(d) Valves shall be balance piston type with float ball.</p> <p>(e) Leather liner shall not be provided.</p> <p>(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.</p> <p>(g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.</p> <p>(h) The valves shall have flanged connections.</p> <p>PAINTING OF VALVES:</p> <p>Two (2) coats of primer followed by three (3) coats of enamel of approved color</p>
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	<p>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.</p>
2.22.00	<p>Tanks and Accessories</p>
2.22.01	<p>The designer and manufacturer of storage tanks shall comply with and obtain approval of all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The tanks shall conform to IS 803/IS804/IS 805/ IS 2825/ API 650/ IS 4049/ IS 4682 (part-I) and IS 4864 to 4870/ ASME B & PV code Sec.-VIII as the case may be.</p>
2.22.02	<p>DESIGN AND CONSTRUCTION</p> <ul style="list-style-type: none"> (a) Design of all vertical atmospheric storage tanks containing water, acid, alkali and other chemical shall conform to IS:803 & API 650. (b) Design of all horizontal atmospheric storage tanks containing water, acid, alkali and other chemicals shall generally conform to IS:2825 as regards to fabrication and general construction taking care of combined bending, shear & hoop stresses developed due to supporting arrangement. (c) Design temperature of vessels shall be 10 deg.C higher than the maximum temperature that any part of the vessel is likely to attain during the course of operation. (d) Tank shall be made from mild steel plates to BS 4360/IS-2062 Gr.B (or equivalent). (e) The joint efficiency factors to be adopted for design calculations shall be in accordance with the specified design code. (f) Tank shall be provided with suitable supporting joints. All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection. (g) The material for flanges shall be of ASTM A 105/ IS-2062 Gr.B. (h) For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature.

<p>2.22.03</p>	<ul style="list-style-type: none"> (i) Vessel seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessel consisting of more than two sections longitudinal seams shall be offset. (j) Tanks shall be provided with float operated level indicators/level gauges/level transmitters and level switches, as required, with complete assembly. Suitable flanged pads for level switches mounting shall also be provided. The level indicator can be top or side mounted as the case may be. (k) In addition to inlet and outlet nozzles, the tanks shall be provided with vents, overflow, drain nozzles complete for various connections on tanks. Overflow lines from storage tanks is to be routed to the nearest surface drains. For tanks containing dm water, alkaline water or power cycle water the vent to atmosphere shall be through carbon-di-oxide absorber vessel suitably mounted on the tank. CO2 absorber vessel shall be provided with the initial fill of chemicals. Similarly for equipment cooling water overhead tank, the overflow & drain from tank shall be combined together and shall be led to nearest drain (at zero level) via. a seal-trough so as not to come directly in contact with atmosphere. (l) Tanks shall have suitable stairs/ladders on inside and outside of the tanks, manholes/inspection covers as required and also platform suitably located. (m) Tank supporting arrangement as approved by Employer shall be provided with all plates/angles/joints/flats and supporting attachment including lugs, saddles, legs etc. (n) Piercing nozzles/pipes from tank body / dish ends shall be adequately compensated as per relevant code. (o) Tank fabrication drg. and design calculations shall be approved by the Project Manager. <p>Corrosion protection</p> <ul style="list-style-type: none"> (a) A corrosion allowance, applicable to surface in contact with corrosive media, when required, shall be taken into consideration. (b) Manholes shall be provided for easy access into the vessels. The size shall be minimum 500 mm and will be with cover plate, nuts bolts, etc. to ensure leak tightness at the test pressure. (c) Each tank shall be provided with drilled cleats welded to the tank for electrical grounding. Material of cleats shall be same as that of the shell.
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.2.22.04	<p>(d) Epoxy-coating shall be provided on the inside of vessel in three coats (minimum) resulting in total thickness of not less than 200 micron in which ever case required, such as equipment cooling water overhead tank, sodium hydroxide tank, condensate surge tank etc.</p> <p>Cleaning & Painting</p> <p>(a) Inside surface of all tanks shall be protected by anti-corrosive paints as required.</p> <p>(b) For tanks/vessel requiring epoxy painting, all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.</p> <p>(c) Outside surfaces of all vessels shall be provided with two coats of primer with three (3) coats of epoxy minimum 100mm DFT resin based paint of approved color.</p>
2.23.00	RUBBER EXPANSION JOINTS
2.23.01	All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
2.23.02	The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
2.23.03	The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
2.23.04	The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
2.23.05	Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
2.23.06	Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipe lines.
2.23.07	The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the'

	<p>duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.</p>
2.23.08	<p>The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.</p>
2.23.09	<p>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.</p>
2.23.10	<p>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.</p>
2.23.11	<p>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.</p>
2.23.12	<p>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.</p>
2.23.13	<p>Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.</p>
2.23.14	<p>Bidder to note that any metallic part which comes in contact with DM /corrosive water shall be of Stainless Steel material.</p>
2.24.00	<p>STRAINERS</p>
2.24.01	<p>Simplex type</p> <p>The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition shall not exceed 1.5 MCW at full flow. Wire mesh of the strainers shall be suitably reinforced, to avoid buckling under operation. Strainer shall have screwed blow off connection fitted with a removable plug. The material of construction of various parts shall be as follows:</p>

2.24.02	<table border="0"> <tr> <td data-bbox="423 239 505 268">(a)</td> <td data-bbox="505 239 776 268">Body</td> <td data-bbox="781 239 1463 338">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)</td> </tr> <tr> <td data-bbox="423 380 505 409">(b)</td> <td data-bbox="505 380 776 443">Strainer Element</td> <td data-bbox="781 380 1463 409">Stainless steel (AISI 316)</td> </tr> <tr> <td data-bbox="423 485 505 514">(c)</td> <td data-bbox="505 485 776 514">End connection</td> <td data-bbox="781 485 1463 548">Screwed upto 50 mm Nb, and Flanged above 50 mm Nb</td> </tr> <tr> <td colspan="3" data-bbox="423 590 1463 619">Duplex type</td> </tr> <tr> <td data-bbox="423 659 505 688">(a)</td> <td colspan="2" data-bbox="505 659 1463 863">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.</td> </tr> <tr> <td data-bbox="423 905 505 934">(b)</td> <td colspan="2" data-bbox="505 905 1463 968">Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.</td> </tr> <tr> <td></td> <td data-bbox="505 1010 776 1039">Body</td> <td data-bbox="781 1010 1463 1146">IS: 318, Gr. 2 up to 50 mm Nb, and IS:210, Gr. FG 260 or ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted above 50 mm NB.</td> </tr> <tr> <td></td> <td data-bbox="505 1188 776 1218">Strainer element</td> <td data-bbox="781 1188 1463 1218">Stainless steel (AISI 316)</td> </tr> <tr> <td></td> <td data-bbox="505 1260 776 1289">End connection</td> <td data-bbox="781 1260 1463 1356">Screwed up to 50mm Nb, and Flanged above 50 mm Nb. Gasket shall be of full face type</td> </tr> <tr> <td data-bbox="423 1398 505 1428">(c)</td> <td colspan="2" data-bbox="505 1398 1463 1461">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.</td> </tr> <tr> <td data-bbox="423 1503 505 1533">(d)</td> <td colspan="2" data-bbox="505 1503 1463 1566">The size of the strainer and the flow direction will be indicated on the strainer body casting.</td> </tr> <tr> <td data-bbox="423 1608 505 1638">(e)</td> <td colspan="2" data-bbox="505 1608 1463 1705">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.</td> </tr> </table>	(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	Duplex type			(a)	The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.		(b)	Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.			Body	IS: 318, Gr. 2 up to 50 mm Nb, and IS:210, Gr. FG 260 or ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted above 50 mm NB.		Strainer element	Stainless steel (AISI 316)		End connection	Screwed up to 50mm Nb, and Flanged above 50 mm Nb. Gasket shall be of full face type	(c)	The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.		(d)	The size of the strainer and the flow direction will be indicated on the strainer body casting.		(e)	Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.	
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2.24.03	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.
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**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**


SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	


**FUNCTIONAL GUARANTEES AND LIQUIDATED
DAMAGES**


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
	<p style="text-align: center;">FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES</p> <p style="text-align: center;">FOR</p> <p style="text-align: center;">SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS</p> <p>(The term "Performance Guarantees" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)".</p>			
1.00.00	PERFORMANCE GUARANTEES			
1.00.01	General Requirements			
	<p>(a) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.</p> <p>(b) 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.</p> <p>(c) The Contractor shall demonstrate all the guarantees covered herein during functional guarantee / acceptance test. The various tests which are to be carried out during performance guarantee/acceptance test are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Employer on each unit individually.</p> <p>(d) All costs associated with the tests shall be included in the bid price.</p> <p>(e) In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. However if the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit specified at clause 1.01.02 of this sub-section, Employer will accept the equipment/system/plant after levying liquidated damages as per clause</p>			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
	<p>1.01.02 of this sub-section. If, however, the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following :</p> <p>(i) For Category-I Guarantees</p> <p>Reject the equipment / system / plant and recover from the Contractor the payments already made</p> <p style="text-align: center;">OR</p> <p>Accept the equipment /system/ plant after levying Liquidated Damages as specified hereunder. The liquidated damages for shortfall in performance indicated in clause 1.01.02 of this sub-section shall be levied separately for each unit. The rates indicated in clause 1.01.02 of this sub-section are on per unit basis. The liquidated damages shall be pro-rated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category-I' Guarantees.</p> <p>(ii) For Category-II Guarantees</p> <p>Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.</p> <p>(iii) For Category-III Guarantees</p> <p>Reject the equipment /system / plant and recover from the Contractor the payments already made.</p> <p style="text-align: center;">OR</p> <p>Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Employer. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as Category-III Guarantees.</p>			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
1.01.00	Guarantees under Category-I			
1.01.01	<p>The performance guarantees which attract liquidated damages are as follows:</p> <ul style="list-style-type: none"> (i) Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at 77 mm Hg (abs) condenser pressure with zero make up at 840 MW unit load (i.e. 105% of rated load). (ii) Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at 77 mm Hg (abs) condenser pressure with zero make up at 800 MW unit load (i.e. 100% of rated load). (iii) Continuous TG output of 840MW unit load (i.e. 105% of rated load) under rated steam conditions at 77 mm Hg (abs) condenser pressure with 0% make-up. (iv) Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 3% make up, design CW temperature and CW flow. <p>Note: The condenser pressure measurement while conducting the guarantee tests from (i) to (iv) above shall be measured at 300 mm above the top row of condenser tubes.</p> <ul style="list-style-type: none"> (v) CW pumping power in KW for design CW flow and the pressure drop on CW side being measured between Bidder's terminal points. (Power consumption shall be computed based on overall efficiency of 83% of CW pump and drive set). (vi) Auxiliary Power Consumption <p>Auxiliary Power Consumption at 100% TMCR (800 MW) Unit Load.</p> <p>The total auxiliary power consumption for all the Turbine Generator auxiliaries and turbine cycle equipments and other common auxiliaries required for continuous unit operation at 800 MW (i.e 100% rate load) under rated steam conditions and at condenser pressure of 77 mm Hg (abs) with 0% make-up shall be guaranteed in line with the requirements stipulated in Clause 1.01.03 of this Sub-Section.</p> <p>Note: Power consumption of each of the pump/fan/compressors etc. wherever mentioned shall be measured with its own drive.</p>			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
1.01.02	<p>AMOUNT OF LIQUIDATED DAMAGES APPLICABLE FOR CATEGORY-I GUARANTEES</p> <p>If the performance guarantee(s) specified at clause 1.01.01 are not met by the Contractor even after the modifications and/or replacements mentioned at clause 1.00.01 (e) of this Sub-section but are achieved within the stipulated Acceptable Shortfall Limit as indicated in this clause, Employer will accept the equipment/system/plant after levying liquidated damages as indicated here under, however, if the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, the Employer may at his discretion reject the equipment/system and recover the payment already made or accept the equipment/system only after levying liquidated damages against the Contractor, at the rates listed herein, and such liquidated damages shall be deducted from the Contract Price:</p>			
	Sl. No.	Guarantee	Rate of Liquidated Damage (LD)	Acceptable Shortfall Limit with LD
	i)	For increase in the guaranteed turbine cycle heat rate		
	a)	At 105% TMCR (840MW) Unit Load	US \$ 179,029 (US dollar One hundred seventy nine thousand and twenty nine only) per 1 Kcal/Kwhr increase in heat rate.	(+) 2.5 % of the guaranteed turbine cycle heat rate.
	b)	At 100% TMCR (800MW) Unit Load	US \$ 682,015 (US dollar Six hundred eighty two thousand and fifteen only) per 1 Kcal/Kwhr increase in heat rate.	(+) 2.5 % of the guaranteed turbine cycle heat rate subject to maximum of 1850 Kcal/Kwhr.
	ii)	For deficiency in Turbine Generator output	US \$ 651 (US dollar Six hundred fifty one only) per 1 KW short fall in TG output	(-) 2% of guaranteed Turbine Generator output
	iii)	For deficiency in condenser pressure	US \$ 987,618 (US dollar Nine hundred eighty seven thousand and six hundred eighteen only) per 1 mmHg increase in condenser pressure	(+) 2.5% of the guaranteed condenser pressure
	iv)	For increase in C.W. pumping power for pressure	US \$ 2,845 (US dollar Two thousand and eight hundred forty five only) per	(+) 1% of the guaranteed C.W. pumping power


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
		drop and C.W. flow in condenser (Power consumption shall be computed based on overall efficiency of 83% for the CW pump and drive set)	1 KW increase in CW pumping power.	
	v)	Auxiliary Power Consumption		
		Auxiliary Power Consumption at 100% TMCR (800 MW) unit load for increase in the auxiliary power consumption in KW guaranteed as per the requirements of Cl.1.01.01(vi) of this Sub Section.	US \$ 2,845 (US dollar Two thousand and eight hundred forty five only) per 1 KW increase in Aux. Power consumption	(+) 1% of the guaranteed auxiliary power consumption
<p>NOTE :</p> <p>i) Each of the liquidated damages specified above shall be independent and these liquidated damages shall be levied concurrently as applicable.</p> <p>ii) If the contract currency is other than US dollars, then the liquidated damages shall be in equivalent amount in contract currency based on Bill selling exchange rate of State Bank of India prevailing on the date of award of contract.</p> <p>iii) All these liquidated damages for short fall in performance shall be deducted from the contract price as detailed in accompanying General Conditions of Contract (GCC)/ Special Conditions of Contract (SCC)</p> <p>iv) Contractor's aggregate liability to pay liquidated damages for failure to attain the functional guarantee shall not exceed twenty five percent (25%) of the Contract Price.</p>				


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
1.01.03	<p>Auxiliary Power Consumption</p> <p>The unit auxiliary power consumption shall be calculated using the following relationship.</p> <p>$P_a = P_u + T_L$</p> <p>P_a = Guaranteed Auxiliary Power Consumption.</p> <p>P_u = Power consumed by the auxiliaries of the unit under test.</p> <p>T_L = Losses of the transformers supplied by bidder based on works test reports.</p> <p>While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries. The auxiliaries to be considered shall include but not be limited to the following :</p> <p>UNIT AUXILIARIES (to be considered for calculating P_u)</p> <ul style="list-style-type: none"> (a) Turbine Unit Oil purifier. (b) Turbine Unit control oil purifier. (c) Electric oil heater for turbine lube oil. (d) Feed and discharge pumps of turbine oil purification system. (e) Main turbine Condenser air evacuation pumps. (f) BFP drive turbine Condenser air evacuation pumps (if envisaged). (g) Main turbine Condenser tube cleaning system pumps. (h) BFP drive turbine Condenser tube cleaning system pumps (if envisaged). (i) Condensate extraction pumps. (j) Drip pump (if envisaged). (k) BFP drive turbine Condensate extraction pumps (if envisaged). (l) Oil purifiers of 2x50% TDBFPs and their feed and discharge pumps. (m) Lube oil pumps of 2x50% TDBFPs and the electrical oil heater for lube oil. 			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES	
1.01.04	<p>(n) Auxiliary oil pump for MDBFP.</p> <p>(o) Oil pumps for HP-LP bypass system.</p> <p>(p) Motor Driven Boiler Feed Pump</p> <p>(For this purpose only 15% of the deemed power consumed by both the MDBFPs at 100% TMCR unit load shall be considered).</p> <p>(q) DM Cooling (normally working) Water pumps to supply cooling water on the secondary (DM) side of the plate type heat exchangers in the closed loop Equipment cooling (Unit auxiliaries) water system.</p> <p>(r) Auxiliary Cooling (normally working) water pumps to supply cooling water on the secondary side of the plate type heat exchangers in the closed loop Equipment cooling (unit auxiliary) water system.</p> <p>(s) One third (33%) of power consumption of one stream of hydrogen generation plant.</p> <p>(t) Power consumption of any other continuously operating auxiliaries for unit operation at different guarantee point loads.</p> <p>Note :</p> <ol style="list-style-type: none"> The bidder shall furnish a list of equipments to be covered under auxiliary power consumption, which shall be subject to Employer's approval. Power consumption at rated duty point sl. no- (s) and (t) to be arrived at based on shop test. Power consumption for hydrogen generation plant at its rated capacity shall be arrived at based on site test. <p>HEAT RATE</p> <p>Turbine Cycle Heat Rate shall be calculated as follows & indicated in all computed heat balance diagrams :</p> $\text{HEAT RATE} = \frac{M1 (H1-h1) + M2 (H3-H2) + \text{Mis} (h1-his) + \text{Mir} (H3 - hir)}{P_g}$ <p>The expression "Mis (h1-his)" in the numerator of the formula is not applicable if spray water to superheater is completely internal to the boiler (i.e. tapped from a location downstream of economizer inlet).</p>	


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
	<p>Where,</p> <p>M1 - Quantity of live steam entering the turbine stop valve including any live steam supplied to valve stems, or glands etc. in Kg/hr.</p> <p>M2 - Quantity of steam from turbine to reheater in Kg/hr.</p> <p>Mir - Quantity of desuperheating water flowing into reheater system for regulation of steam temperature in Kg/hr.</p> <p>Mis - Superheater desuperheating spray flow in Kg/hr.</p> <p>H1 - Enthalpy in kcal/kg of live steam.</p> <p>H2 - Enthalpy in kcal/kg of steam to reheat.</p> <p>H3 - Enthalpy in kcal/kg of reheated steam.</p> <p>h1 - Enthalpy of feed water in kcal/kg at the downstream of the junction of feed flow and bypass flow of HP heaters.</p> <p>hir - Enthalpy of desuperheating water flowing into reheat system in Kcal/Kg.</p> <p>his - Enthalpy of superheater desuperheating spray water in Kcal/Kg.</p> <p>Pg - Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 840MW, and 800MW respectively for 105%, and 100% TMCR unit load:</p> <ul style="list-style-type: none"> (a) Power taken by Excitation system (KW) including transformer losses, as applicable for various guarantee points, in case of static excitation system is offered. (The transformer losses at various points shall be based on factory test to be conducted). (b) Power required for ventilation of oil and control fluid tanks, if ventilating fans are separately driven (KW). (c) Power required for lubrication, if lubricating pumps are separately driven (KW). (d) Power required for control fluid pumps, if control fluid pumps are separately driven (KW). (e) Power required for hydrogen, seal oil auxiliaries, if separately driven (KW). 			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
	<p>(f) Power required for stator water cooling system, if cooling pumps are driven separately (KW).</p> <p>It may be noted that the heat balance diagrams and guarantees shall be furnished considering zero spray water quantity for superheater and reheater spray. During Performance Guarantee Testing, in case water is required for superheater and/or reheater temperature control, the contractor shall be entitled to heat rate correction as per correction curves to be submitted by him with his offer.</p>			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
1.02.00	GUARANTEES UNDER CATEGORY - II NIL			


CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
	GUARANTEES UNDER CATEGORY - III			
1.03.00	The parameters/capabilities to be demonstrated for various systems/ equipments shall include but not be limited to the following:			
1.03.01	Noise	<p>All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in General Technical Requirement, Part-C Section-VI of the technical specifications.</p> <p>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.</p> <p>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.</p> <p>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.</p>		
1.03.02	Condenser On Load Tube Cleaning System	<p>Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer and accepted by the Employer.</p>		
1.03.03	Deaerator	<p>Dissolved O₂ content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine method.</p>		

CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES		
1.03.04	<p>Turbine hall and other EOT Crane :</p> <p>Over load test, travel & hoist speed checks etc., shall be demonstrated as per IS: 3177 (latest edition).</p>		
1.03.05	<p>Equipment Cooling Water System</p> <p>Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.</p>		
1.03.06	<p>Condensate Polishing Unit</p> <p>i) Effluent quality at outlet of each vessel at its rated design flow and design service length between two regenerations.</p> <p>ii) Pressure drop across the polisher service vessel (as defined elsewhere) in clean and dirty condition of resin at rated design flow.</p>		
1.03.07	<p>Hydrogen Generation Plant</p> <p>i) Capacity & discharge pressure of hydrogen gas compressors at its rated duty point with its job (own) motor shall be demonstrated and proved at shop.</p> <p>ii) Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of Hydrogen shall be demonstrated at site.</p> <p>iii) Hydrogen generation plant capacity (stream wise) shall be demonstrated at site.</p>		
1.03.08	<p>EOT, HOT Cranes & Monorail Hoist : Over load tests, travel and hoist speed checks as per relevant Indian standard IS (latest edition).</p>		
1.03.09	<p>Passenger Lifts for TG Building & Service Building : Over load tests, travel and hoist speed checks.</p>		
1.03.10	<p>Electrical System</p> <p>As applicable and/or as specified in the technical specification in electrical Sub-section.</p>		

CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
2.00.00	PERFORMANCE GUARANTEE / ACCEPTANCE TEST			
2.01.00	General Requirements			
2.01.01	It is the responsibility of the Contractor to perform the Performance Guarantee/Acceptance test as specified in this Sub-Section. The performance tests will be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.			
2.01.02	The Contractor shall make their system ready for the performance guarantee tests.			
2.01.03	<p>All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation required for performance tests shall be supplied by the contractor and shall be retained by him upon satisfactory completion of all such tests at site. All costs associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the bid price. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.</p> <p>Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.</p>			
2.01.04	<p>The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following :</p> <ul style="list-style-type: none"> (a) Object of the test. (b) Various guaranteed parameters & tests as per contract. (c) Method of conductance of test and test code. (d) Duration of test, frequency of readings & number of test runs. (e) Method of calculation. (f) Correction curves. (g) Instrument list consisting of range, accuracy, least count, and location of instruments. 			

CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
	<p>(h) Scheme showing measurement points.</p> <p>(i) Sample calculation.</p> <p>(j) Acceptance criteria.</p> <p>(k) Any other information required for conducting the test.</p> <p>The Performance / Acceptance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. After the conductance of Performance test, the contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one month from the date of conductance of Performance test. In case post test calibration takes longer time then modalities for submission of PG test report by the bidder shall be mutually agreed upon during the test. However, test data shall be submitted to the Employer after completing each test run.</p>			
2.01.05	<p>Test Interruptions</p> <p>In the event of a test interruption resulting from an Event of Force Majeure or Employer-Caused-Delay, Contractor shall be entitled to relief as provided in the contract, provided that, the interrupted Performance Test must be started again and test data that were collected during the interrupted test must be ignored.</p>			
2.02.00	<p>Turbine Generator Performance/ Acceptance Test</p>			
2.02.01	<p>Performance test for the turbine generator set will be conducted in accordance with the latest edition of ASME PTC-6. Such test shall be binding on the parties to the contract to determine compliance with the guaranteed heat balance conditions at 840 MW (105% TMCR) MW and 800 MW (100% TMCR) unit outputs corresponding to the conditions stipulated under Cl. 1.22.01 of Sub-section- A-3 (Turbine Generator and Auxiliaries), Part-B. Power consumed by the auxiliaries mentioned under clause 1.01.03 of this Sub-section which is to be deducted from electrical power generated, shall be measured during the performance / Acceptance Test. Wherever the measurement is not possible, design values of power consumption by an auxiliary shall be considered.</p>			
2.02.02	<p>The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes. All the necessary instruments (in duplicate) required for the tests shall be furnished by the contractor so as to meet the accuracies specified in the codes. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the contractor, if required. For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap</p>			

CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
2.02.03	<p>nozzle assembly including required machined straight lengths meeting the requirement of ASME PTC-6 shall be provided. The test procedures, Calibration Standards, Calibration procedures etc., shall be subject to Employer's approval. All the instruments including the flow nozzle shall be calibrated by the contractor before and after the test, in a reputed international institute as approved by the Employer. However, post test calibration of flow nozzle shall not be mandatory. During the test if it is found that the parameters are in order as regards to calibrations of instruments and after post test calibration of instruments, the difference between pre test and post test calibrations is within code acceptable limits, bidder shall submit the report of PG test results based on pre test effects (calibration) of instruments. These calibrations shall be performed in the presence of the Employer. All calibrations shall be made available prior to the test and calibration certificates in original submitted to Employer at least 15 days before conductance of the test for Employer's approval. The instruments shall be sealed after calibration by calibrating lab. The percentage calibration error/deviation should not be more than accuracy class of the instrument. Calibration low beta ratio throat tap nozzle assembly including flow straightner, upstream and down stream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC6.</p> <p>Secondary flow devices shall be calibrated flow nozzle / orifice plate as per ASME-PTC 19.5.</p> <p>Corrections to the test results for steam turbine shall be applied as per the correction curves listed in detailed technical specification Part-B. When the system is properly isolated for a performance test, the unaccounted for leakages should not be more than 0.1% of the design throttle flow at that load. To achieve the above value of unaccounted for leakages, the Bidder shall prepare the unit during pretest available shutdown. However, during the test, if it is found that the unaccounted for leakage is more than 0.1% of design throttle flow at that load, then heat rate will be increased by an amount equal to half the difference between actual unaccounted for leakage expressed as percentage of design throttle flow at that load and 0.1% (allowed by the code). If the unaccounted leakage during the test shall be more than 0.3 % of design throttle flow at that load and appreciable leakage is visible in Boiler area, mutual agreement shall be made regarding consideration of excess leakage in the calculation of test results.</p>			
2.02.04	<p>The performance guarantee test will be carried out after successful completion of initial operation. Ageing allowance will be given during evaluation of PG test results and hence guaranteed heat rates shall be increased by the amount calculated as per the formula given in Cl. No. 3.07, Sub-Section-3 of ASME-PTC-6 Report 1985 (Reaffirmed 1991). Period of ageing shall be considered from the date of first synchronization to the date of conductance of PG test.</p> <p>In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered</p>			

CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES			
2.02.05	<p>The tests shall be arranged in a manner that the EMPLOYER's operation is not disrupted. Duplicate test runs shall be performed at 840 MW and 800 MW unit loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, third test shall be run at the same point. The corrected result of any one of the three test runs, which deviates from the corrected averaged result of all the runs by more than 0.25%, shall be eliminated; otherwise the results of all the three tests runs shall be accepted.</p>			
2.02.06	<p>During Performance/ Acceptance test, following tests shall be carried out for T.G. set with test grade instruments as per ASME code.</p> <ul style="list-style-type: none"> (i) Guarantee Turbine Cycle Heat rate test at 840MW (105% rated load) corresponding to the heat balance diagram specified in Sub-Section-A-3, Part-B, Section-VI. (ii) Guarantee Turbine Cycle Heat rate test at 800MW corresponding to the heat balance diagram specified in Sub-Section-A-3, Part-B, Section-VI. (iii) Guarantee Output test of 840 MW (105% rated load) corresponding to the heat balance diagram specified in Sub-Section-A-3, Part-B, Section-VI. (iv) CW pumping power in KW for design CW flow and the pressure drop on CW side being measured between Bidder's terminal points. (Power consumption shall be computed based on overall efficiency of 83% of CW pump and drive set). 			
2.02.07	<p>Performance test for the condensers will be conducted in accordance with the latest edition of ASME PTC-12.2 with the exception at (a) mentioned below :</p> <ul style="list-style-type: none"> (a) Condenser pressure will be measured at 300 mm above the top row of tubes under VWO conditions, 3% make-up and design C.W. flow & design temperature. The condenser pressure shall be measured with a vacuum grid utilising ASME basket tips. The grid is fitted at 300 mm above top row of condenser tubes. (b) Combined pressure drop in condenser tube, waterbox, and inlet and outlet piping will be measured in between intake and discharge point of the C.W. system at BIDDER'S terminal points with cleanliness factor of 0.9 and COLTCS in service. 			
2.03.00	<p>Test Reports</p> <p>The Contractor shall prepare test reports for the Availability Test, Efficiency Test, Capacity Test and the Emissions test, in which the methods followed, instrument readings, graphs, observations, final results obtained, etc., shall be recorded.</p>			



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	

**TECHNICAL SPECIFICATION FOR EMPTY HYDROGEN
NITROGEN CYLINDERS**



TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT 2 X 800 MW NTPC GADERWARA STPP STAGE-I

SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	

EMPTY HYDROGEN / NITROGEN CYLINDER (46.7 liters water capacity)

1.0 SCOPE

This specification covers the design, manufactures, 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" diameter and screw internally to diameter 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 seamless 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:



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

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- a) The standard to which cylinders and fittings confirm.
- b) Capacity, size and wall thickness of cylinder.
- c) Details and arrangement of fittings.
- d) 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 department 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 shall be submitted in 5 copies.



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

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SECTION – D2

**DESIGN REQUIREMENTS
ELECTRICAL**

Note: Some of the design requirement specified in section D2 may not be relevant to the bidder design. Only the requirements relevant for bidder's system shall be considered by the bidder.



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO.PE-TS-394-168-A001

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DATE

SHEET

MOTORS

<p>5.00.00</p>	<p>equipment under entire operating range including voltage and frequency variations.</p> <p>(c) For BFP motors starting MVA shall be restricted to 80 MVA.</p> <p>TEMPERATURE RISE</p> <p>Air cooled motors</p> <p>70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.</p> <p>Water cooled</p> <p>80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation.</p>
<p>6.00.00</p> <p>6.01.00</p> <p>6.01.01</p> <p>6.01.02</p> <p>6.01.03</p> <p>6.01.04</p> <p>6.02.00</p> <p>6.02.01</p> <p>6.02.02</p> <p>6.03.00</p>	<p>OPERATIONAL REQUIREMENTS</p> <p>Starting Time</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.</p> <p>Torque Requirements</p> <p>Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.</p> <p>Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.</p> <p>Starting voltage requirement</p> <p>(a) 85% below 110 KW</p> <p>(b) 80% from 110 KW to 200 KW</p>

	<p>(c) 85% above 200 KW to 1000 KW</p> <p>(d) 80% from 1001 KW to 4000 KW</p> <p>(e) 75% above 4000KW</p> <p>Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.</p>
7.00.00	DESIGN AND CONSTRUCTIONAL FEATURES
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors , space heater terminals inside the main terminal box may be acceptable.
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below
	<p>(a) Fuel oil area : Group – IIB</p> <p>(b) Hydrogen generation :Group - IIC (or Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)</p>
7.03.00	<p>Winding and Insulation</p> <p>(a) Type : Non-hygroscopic, oil resistant, flame resistant</p> <p>(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.</p> <p>(c) 11kV & 3.3 kV AC motors : Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15</p> <p>(d) 240VAC, 415V AC & 220V DC motors : Thermal Class(B) or better</p>
7.04.00	Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
7.06.00	Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 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.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors.
7.08.00	Motor body shall have two earthing points on opposite sides.
7.09.00	HT motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided. In case cable box is offered, then Employer shall provide termination kit. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.
7.10.00	The spacing between gland plate & centre of terminal stud shall be as per Table-I.
7.11.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.12.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.
7.13.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.14.00	11kV and 3.3 kV motor Terminal Box shall be suitable for fault level of 750MVA for 0.12 sec and 250 MVA for 0.12 sec respectively. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.
7.15.00	The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.
8.00.00	The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.

	<p>(a) Below 110KW : 10.0</p> <p>(b) From 110 KW & upto 200 KW : 9.0</p> <p>(c) Above 200 KW & upto 1000KW : 10.0</p> <p>(d) From 1001KW & upto 4000KW : 9.0</p> <p>(e) Above 4000KW : 6 to 6.5</p>
10.00.00	TYPE TEST
10.01.00	HT MOTORS
10.01.01	The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII- (BPS) and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
10.01.02	<p>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,</p> <p>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.</p>
10.01.03	In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the owner 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 owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
10.01.04	<p>Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED"and carried out within last ten years from the date of bid opening. These reports</p> <p>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</p>

10.01.05	<p>contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p> <p>LIST OF TYPE TESTS TO BE CONDUCTED</p> <p>The following type tests shall be conducted on each type and rating of HT motor</p> <ul style="list-style-type: none"> (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary excess torque test (subject to test bed constraint). (d) Full load test(subject to test bed constraint) (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose. (f) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15 (g) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15
10.01.06	<p>LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED</p> <p>The following type test reports shall be submitted for each type and rating of HT motor</p> <ul style="list-style-type: none"> (a) Degree of protection test for the enclosure followed by IR, HV and no load run test. (b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.
10.02.00	<p>LT Motors</p>
10.02.01	<p>LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last <i>ten</i> years from the date of bid opening.</p>

10.02.02	<p>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.</p>
10.02.02	<p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p>
10.02.03	<p>LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED</p> <p>The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only</p> <ol style="list-style-type: none"> 1. Measurement of resistance of windings of stator and wound rotor. 2. No load test at rated voltage to determine input current power and speed 3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors) 4. Full load test to determine efficiency power factor and slip . 5. Temperature rise test . 6. Momentary excess torque test. 7. High voltage test . 8. Test for vibration severity of motor. 9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section) 10. Test for degree of protection and 11. Overspeed test. 12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1
10.03.00	<p>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.</p>

10.04.00

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm As per manufacturer's practice.
UP to 3 KW	
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	Clearance
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm



**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO.PE-TS-394-168-A001

VOLUME-IIB

SECTION

REV.NO.0

DATE

SHEET

CABLES

LT POWER CABLES

1.00.00

CODES & STANDARDS

1.01.00

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.
IEC-332	Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

2.00.00	TECHNICAL REQUIREMENTS														
2.01.00	The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.														
2.02.00	Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.														
2.03.00	Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be stranded.														
2.04.00	XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.														
2.05.00	The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.														
2.06.00	<p>For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanised steel as follows :</p> <table border="0"> <thead> <tr> <th data-bbox="391 1213 727 1276">Calculated nominal dia. of cable under armour</th> <th data-bbox="906 1213 1230 1245">Size and Type of armour</th> </tr> </thead> <tbody> <tr> <td data-bbox="391 1318 548 1350">Upto 13 mm</td> <td data-bbox="748 1318 987 1350">1.4mm dia GS wire</td> </tr> <tr> <td data-bbox="391 1388 686 1419">Above 13 & upto 25mm</td> <td data-bbox="748 1388 1373 1419">0.8 mm thick GS formed wire / 1.6 mm dia GS wire</td> </tr> <tr> <td data-bbox="391 1451 695 1482">Above 25 & upto 40 mm</td> <td data-bbox="748 1451 1357 1482">0.8mm thick GS formed wire / 2.0mm dia GS wire</td> </tr> <tr> <td data-bbox="391 1514 686 1545">Above 40 & upto 55mm</td> <td data-bbox="748 1514 1357 1545">1.4 mm thick GS formed wire /2.5mm dia GS wire</td> </tr> <tr> <td data-bbox="391 1566 695 1598">Above 55 & upto 70 mm</td> <td data-bbox="748 1566 1373 1598">1.4mm thick GS formed wire / 3.15mm dia GS wire</td> </tr> <tr> <td data-bbox="391 1629 561 1661">Above 70mm</td> <td data-bbox="748 1629 1373 1661">1.4 mm thick GS formed wire / 4.0 mm dia GS wire</td> </tr> </tbody> </table>	Calculated nominal dia. of cable under armour	Size and Type of armour	Upto 13 mm	1.4mm dia GS wire	Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire	Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire	Above 40 & upto 55mm	1.4 mm thick GS formed wire /2.5mm dia GS wire	Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire
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Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire														
Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire														

<p>2.06.01</p> <p>2.06.02</p> <p>2.07.00</p> <p>2.08.00</p> <p>2.09.00</p> <p>2.10.00</p>	<p>The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.</p> <p>The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of G.S.wire/ formed wire.</p> <p>Outer sheath shall be of PVC as per IS: 5831 & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.</p> <p>(a.) Oxygen index of min. 29 (as per IS 10810 Part-58).</p> <p>(b.) Acid gas emission of max. 20% (as per IEC-754-I).</p> <p>(c.) Smoke density rating shall not be more than 60 % (as per ASTMD-2843).</p> <p>Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:</p> <p>1 core - Red, Black, Yellow or Blue</p> <p>2 core - Red & Black</p> <p>3 core - Red, Yellow & Blue</p> <p>4 core - Red, Yellow, Blue and Black</p> <p>For reduced neutral conductors, the core shall be black.</p> <p>In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.</p> <p>(a.) Cable size and voltage grade - To be embossed</p> <p>(b.) Word 'FRLS' at every 5 metre - To be embossed</p> <p>(c.) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed</p> <p>The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.</p>
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<p>2.11.00</p> <p>2.12.00</p> <p>2.13.00</p> <p>3.00.00</p> <p>3.01.00</p> <p>302.00</p> <p>3.03.00</p> <p>3.04.00</p>	<p>All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.</p> <p>Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum, over the declared value in the technical data sheets.</p> <p>In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.</p> <p>Cable selection & sizing</p> <p>LT Power cables shall be sized based on the following considerations:</p> <ul style="list-style-type: none"> (a) Rated current of the equipment (b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage (c) Short circuit withstand capability <p>This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.</p> (d) The minimum conductor size shall be 6 sqmm for aluminium conductor cables and 2.5 sqmm for copper conductor cables. The constructional details of copper conductor cables shall be same as indicated for copper control cable. <p>Derating Factors</p> <p>Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:</p> <ul style="list-style-type: none"> a) Variation in ambient temperature for cables laid in air b) Grouping of cables c) Variation in ground temperature and soil resistivity for buried cables. <p>Cable lengths shall be considered in such a way that straight through cable joints are avoided.</p> <p>Cables shall be armoured type if laid in switchyard area or directly buried.</p>
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3.05.00	All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated and preferable sizes are 1Cx150, 1Cx300, 1Cx630, 3Cx150 & 3Cx240 sq.mm.
4.00.00	<p>CONSTRUCTIONAL FEATURES</p> <p>(a.) 1.1 KV grade XLPE power cables shall have compacted aluminium conductor, XLPE insulated, PVC inner sheathed (as applicable), armoured/ unarmoured, FRLS PVC outer sheathed conforming to IS:7098. (Part-I).</p> <p>(b.) 1.1KV grade PVC power cables shall have aluminium conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed, armoured/ unarmoured, FRLS PVC outer sheathed conforming to IS:1554 (Part-I).</p>
5.00.00	<p>CABLE DRUMS</p> <p>(a) Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.</p> <p>(b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.</p> <p>(c) The standard drum length for power cables shall not be less than 500 meters. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drum with shorter lengths. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/- 2%.</p>
5.00.00	TYPE TESTS
5.01.00	<p>General</p> <p>All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the</p>

date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

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.

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

5.02.00

Type Tests

5.02.01

The reports for the following type tests shall be submitted for one size each of LT XLPE and LT PVC Power cables. Size shall be decided by the employer during detailed engineering :

S.No.	Type test	Remarks
For Conductor		
1.	Resistance test	
2.	Tensile test	For circular non-compacted conductors only
3.	Wrapping test	For circular non-compacted only
For Armour Wires/ Formed Wires		
4.	Measurement of Dimensions	
5.	Tensile Test	
6.	Elongation test	

7.	Torsion test		For round wires only
8.	Wrapping test		For aluminium wires / formed wires only.
9.	Resistance test		
10(a)	Mass of zinc coating test		For GS Formed wires/wires only
10(b)	Uniformity of zinc coating		For GS Formed wires /wires only
11.	Adhesion test		For GS Formed wires/wires only
	For PVC/XLPE insulation & PVC Sheath		
12.	Test for thickness		
13.	Tensile strength & elongation	before ageing and after ageing tests	
14.	Ageing in air oven		
15.	Loss of mass test		For PVC insulation and sheath only
16.	Hot deformation test		For PVC insulation and sheath only
17.	Heat shock test		For PVC insulation and sheath only
18.	Shrinkage test		
19.	Thermal stability test		For PVC insulation and sheath only
20.	Hot set test		For XLPE insulation only
21.	Water absorption test		For XLPE insulation only
22.	Oxygen index test		For outer sheath only
23.	Smoke density test		For outer sheath only

	24.	Acid gas generation test For outer sheath only
		For completed cables
	25.	Insulation resistance test (Volume resistivity method)
	26.	High voltage test
	27.	Flammability test as per IEC-332 Part-3 (Category-B)
5.02.02		Acceptance Tests (as per QA table)
5.02.03		Routine Tests (as per QA table)

LT CONTROL CABLES	
1.00.00	CODES & STANDARDS
1.01.00	<p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes :</p> <p>IS :1554 - I PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.</p> <p>IS : 3961 Recommended current ratings for cables</p> <p>IS : 3975 Low carbon galvanised steel wires, formed wire and tapes for armouring of cables.</p> <p>IS : 4905 Methods for random sampling.</p> <p>IS : 5831 PVC insulation and sheath of electrical cables.</p> <p>IS : 8130 Conductors for insulated electrical cables and flexible cords.</p> <p>IS : 10418 Specification for drums for electric cables.</p> <p>IS : 10810 Methods of tests for cables.</p> <p>ASTM-D -2843 Standard test method for density of smoke from the burning or decomposition of plastics.</p> <p>IEC-754 (Part-I) Test on gases evolved during combustion of electric cables.</p> <p>IEC -332 Tests on Electric cables under fire conditions Part-3 : Tests on bunched wires or cables (category - B)</p>
2.00.00	TECHNICAL REQUIREMENTS
2.01.00	The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.

2.02.00	Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.														
2.03.00	Conductor of control cables shall be made of multi stranded, plain annealed copper.														
2.04.00	PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.														
2.05.00	The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.														
2.06.00	<p>For multicore armoured cables, the armouring shall be of galvanised steel as follows :-</p> <table border="0" data-bbox="423 800 1299 1459"> <thead> <tr> <th data-bbox="423 800 893 863">Calculated nominal dia of cable under armour</th> <th data-bbox="893 800 1299 863">Size and Type of armour</th> </tr> </thead> <tbody> <tr> <td data-bbox="423 905 893 947">1) Upto 13 mm</td> <td data-bbox="893 905 1299 947">1.4mm dia GS wire</td> </tr> <tr> <td data-bbox="423 968 893 1031">2) Above 13 upto 25 mm</td> <td data-bbox="893 968 1299 1031">0.8 mm thick GS formed wire / 1.6 mm dia GS wire</td> </tr> <tr> <td data-bbox="423 1073 893 1136">3) Above 25 upto 40 mm</td> <td data-bbox="893 1073 1299 1136">0.8mm thick GS formed wire / 2.0mm dia GS wire</td> </tr> <tr> <td data-bbox="423 1178 893 1241">4) Above 40 upto 55mm</td> <td data-bbox="893 1178 1299 1241">1.4 mm thick GS formed wire/ 2.5mm dia GS wire</td> </tr> <tr> <td data-bbox="423 1283 893 1346">5) Above 55 upto 70 mm</td> <td data-bbox="893 1283 1299 1346">1.4mm thick GS formed wire / 3.15mm dia GS wire</td> </tr> <tr> <td data-bbox="423 1388 893 1451">6) Above 70mm</td> <td data-bbox="893 1388 1299 1451">1.4 mm thick GS formed wire / 4.0 mm dia GS wire</td> </tr> </tbody> </table> <p data-bbox="423 1493 1299 1661">The gap between armour wire / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface.</p>	Calculated nominal dia of cable under armour	Size and Type of armour	1) Upto 13 mm	1.4mm dia GS wire	2) Above 13 upto 25 mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire	3) Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire	4) Above 40 upto 55mm	1.4 mm thick GS formed wire/ 2.5mm dia GS wire	5) Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire	6) Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire
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5) Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire														
6) Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire														
2.07.00	Outer sheath shall be of PVC(grade as applicable) and grey in colour . In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.														

<p>2.08.00</p> <p>2.09.00</p> <p>2.10.00</p>	<p>(a) Oxygen index of min. 29 (As per IS:10810 (part-58))</p> <p>(b) Acid gas emission of max. 20% (As per IEC-754-I).</p> <p>(c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM-D-2843.</p> <p>Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.</p> <p>1 core - Red, Black, Yellow or Blue</p> <p>2 core - Red & Black</p> <p>3 core - Red, Yellow & Blue</p> <p>4 core - Red, Yellow, Blue and Black</p> <p>5 core - Red, Yellow, Blue, Black and Grey</p> <p>For cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.</p> <p>In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath :</p> <p>(a) Cable size and voltage grade - To be embossed</p> <p>(b) Word 'FRLS' at every 5 metre - To be embossed</p> <p>(c) Sequential marking of length of the cable in metres at every one metre. - To be embossed / printed.</p> <p>The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible.</p>
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2.11.00	All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part -3.
2.12.00	Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum over the declared value in the technical data sheets.
2.13.00	In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.
2.14.00	Cable selection & sizing
2.14.01	<p>LT Control cables shall be sized based on the following considerations:</p> <ul style="list-style-type: none"> (a) Rated current of the equipment (b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage (c) Short circuit withstand capability <p style="margin-left: 40px;">This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.</p> (d) The minimum size of conductor shall be 1.5 sqmm
2.14.02	<p>Derating Factors</p> <p>Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:</p> <ul style="list-style-type: none"> a) Variation in ambient temperature for cables laid in air b) Grouping of cables c) Variation in ground temperature and soil resistivity for buried cables.
2.14.03	Cable lengths shall be considered in such a way that straight through cable joints are avoided.
2.14.04	Cables shall be armoured type if laid in switchyard area or directly buried.

<p>3.00.00</p>	<p>CONSTRUCTIONAL FEATURES</p>
<p>3.01.00</p>	<p>1.1 KV Grade Control Cables</p> <p>Control Cables shall have stranded copper conductor multicore PVC insulated, PVC inner-sheathed, armoured / unarmoured, PVC outer-sheathed conforming to IS:1554. (Part-I).</p>
<p>3.02.00</p>	<p>Cable Drums</p> <p>(a) Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS : 10418.</p> <p>(b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both the sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.</p> <p>(c.) The standard drum length for control cables shall not be less than 1000 metres. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drums with shorter lengths. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/- 2%.</p>
<p>4.00.00</p>	<p>TESTS</p>
<p>4.01.00</p>	<p>GENERAL</p> <p>All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the 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.</p>

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

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.

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

4.02.00

TYPE TESTS:

4.02.01

The Type tests reports for the following shall be submitted for one size of LT control cable :

S. No.	Type Test	Remarks
a)	For Conductor	
1.	Resistance test	
b)	For Armour Wires / Formed wires	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	
5.	Torsion test	For round wire only
6.	Winding test	For Formed wires
7.	Resistance test	
8.	Zinc Coating test	For G.S. conductors only.
c)	For PVC insulation & PVC Sheath	
9.	Test for thickness	


	<ul style="list-style-type: none"> 10. Tensile strength and elongation test before ageing and after ageing 11. Ageing in air oven 12. Loss of mass test For PVC insulation and sheath only 13. Hot deformation test For PVC insulation and sheath only 14. Heat shock test For PVC insulation and sheath only 15. Shrinkage test 16. Thermal stability test For PVC insulation and sheath only 17. Oxygen index test For outer sheath only 18. Smoke density test For outer sheath only 19. Acid gas generation test For outer sheath only <p>d) For completed cables</p> <ul style="list-style-type: none"> 20. Insulation resistance test (Volume resistivity method) 21. High voltage test 23. Flammability test as per IEC - 332 Part-3 (Category-B)
4.02.02	Acceptance Tests (as per QA table)
4.03.00	Routine Tests (as per QA table)





**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**


SPEC NO.PE-TS-394-168-A001	
VOLUME-IIB	
SECTION	
REV.NO.0	DATE
SHEET	


ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS


CLAUSE NO.	TECHNICAL REQUIREMENTS	
1.00.00	CODES AND STANDARDS:	
1.01.00	All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.	
2.00.00	ELECTRIC ACTUATORS WITH INTEGRAL STARTERS	
2.01.00	TYPE:	
2.01.01	The actuators shall have integral starters along with over load relays with built in SPP (Single Phasing Preventer). A 415, 3 phase 3 wire power supply shall be given to the actuator from vendor's/employer's switch board as applicable through a switch fuse unit. Control voltage of the motor starter shall be 110 V AC / 24 V DC, derived suitably from 415V power supply.	
2.01.02	In case supplier's standard control voltage for Open/Close contactors is 110V AC, the same is acceptable if suitable Opto Isolation circuit is provided with coupling relays for 24 V DC command inputs.	
2.02.00	INTERFACES:	
2.02.01	<p>Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.</p> <p>(a) For Binary Drive (both ON-OFF and INCHING type) :- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.</p> <p>Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.</p> <p>(b) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided</p> <p>(c) Open/close command termination logic shall be suitably built inside actuator.</p>	
2.03.00	RATING :	
2.03.01	(a) Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%.	
2.03.02	(b) Sizing:-	
2.03.03	Open/Close at rated speed against designed differential pressure at 90% of rated voltage.	
2.03.04	For isolating service:- Three successive open-close operations or 15 mins, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.	
2.04.00	CONSTRUCTION:	
2.04.01	(a) Enclosure:	
2.04.02	Totally enclosed weatherproof minimum IP-55 degree of protection.	

CLAUSE NO.	TECHNICAL REQUIREMENTS	
<p>2.05.00</p>	<p>(b) Gear Train : Metal (Fibre gears are not acceptable)) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energized.</p> <p>(c) Manual Wheel: Shall disengage automatically during motor operation.</p> <p>MOTOR :</p> <p>(a) Type : Squirrel cage induction motor suitable for Direct On Line (DOL)starting.</p> <p>(b) Enclosure: Totally enclosed, self ventilated IP-55 degree of protection.</p> <p>(c) Insulation Class B or better. Temperature rise 70 Deg C. over 50 Deg C ambient</p> <p>(d) Bearings: Double shielded, grease lubricated antifriction.</p> <p>(e) Earth Terminals: Two</p> <p>(f) Protection: Single Phasing Protection, Over heating protection through Thermostat and wrong phase sequence protection shall be provided over and above other protection features standard to bidder's design Suitable means shall be provided to diagnose the type of fault locally.</p>	
<p>2.06.00 2.06.01</p>	<p>POSITION/TORQUE SWITCHES:</p> <p>Four nos. (2 each in open and close position) position limit switches and two nos. (one in open and other in close direction) torque switches each having two nos. NO and two nos. NC contacts shall be provided. A single shaft shall actuate all contacts of limit switches at each position.</p> <p>Limit switch and disturbance signals shall be available to DCS even when the power supply to the actuators is not available.</p> <p>Torque switches shall be bypassed in both the end positions with the other end Limit switches.</p> <p>Limit switches</p> <p>Limit switches shall be Silver plated with high conductivity and non –corrosive type. Contact rating shall be sufficient to meet the requirement of Control System subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP-55.</p>	

CLAUSE NO.	TECHNICAL REQUIREMENTS	
2.07.00	LOCAL OPERATION:	
2.07.01	It shall be possible to operate the actuator locally also. Lockable local/remote selection shall be provided on the actuator.	
2.08.00	POSITION INDICATOR :	
2.08.01	To be provided for 0 to 100% travel.	
2.09.00	POSITION TRANSMITTER (FOR MODULATING/INCHING TYPE) :	
2.09.01	As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.	
2.10.00	WIRING :	
2.10.01	Suitable voltage grade copper wire.	
2.11.00	TERMINAL BOX :	
	(i) 9 pin plug and socket (1 no. per actuator to suit 4 pair 0.5 sq.mm. copper overall shielded (16 mm OD), instrumentation cable) suitably mounted in the starter box itself to terminate open/close command and status feedback signals with external control systems.	
	(ii) Additional one number 9 pin plug and socket (to suit 4 pair 0.5 sq.mm copper (16 mm OD) individual and overall shielded instrumentation cable) suitably mounted in the starter box itself for actuators with 4-20 mA position transmitters.	
	(iii) Necessary glands for power cables shall be provided.	
2.12.00	TERMINAL BLOCK :	
2.12.01	650V grade. For power cables.	
2.13.00	SPACE HEATER :	
2.13.01	Space heater of suitable rating. The supply shall be derived from the main power supply available in the actuator.	
2.14.00	TYPICAL WIRING DIAGRAM :	
2.14.01	Refer Tender Drawing No. 0000-999-POI-A-063.	
3.00.00	TRAINING Contractor shall provide training on Integral Actuator for Employer's personnel. The duration of the training shall be as elaborated in Part-C, Section-VI of technical specifications.	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-SS-394-145-I007		
			VOLUME	II B	
			SECTION	D	
			REV. NO.	00	DATE: 01.08.13
			SHEET	1	OF 3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)		
GENERAL*	* PROJECT	2X800 MW GADARWARA-TG			
	OFFER REFERENCE				
	* TAG NO. SERVICE				
	* DUTY	<input type="checkbox"/> ON / OFF <input type="checkbox"/> INCHING			
	* LINE SIZE (inlet/outlet): MATERIAL				
	* VALVE TYPE	<input type="checkbox"/> GLOBE <input type="checkbox"/> GATE <input type="checkbox"/> REG. GLOBE <input type="checkbox"/> BUTTERFLY			
	* OPENING / CLOSING TIME				
	* WORKING PRESSURE				
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%			
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY			
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY			
ACTUATOR RATED TORQUE	BIDDER TO SPECIFY				
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:55			
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL			
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.			
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.			
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.			
HANDWHEEL	* REQUIRED	<input type="checkbox"/> YES <input type="checkbox"/> NO			
	* ORIENTATION	<input type="checkbox"/> TOP MOUNTED <input type="checkbox"/> 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	<input checked="" type="checkbox"/> ENCLOSED (BIDDER TO CONFIRM) A: <input type="checkbox"/> DRG. NO. 3-V-MISC-24227 R00 B: <input type="checkbox"/> DRG. NO. 3-V-MISC-24550 R00 C: <input checked="" type="checkbox"/> DRG. NO. 3-V-MISC-24283 R00 D: <input type="checkbox"/> DRG. NO. 4-V-MISC-90271 R11 E: <input type="checkbox"/> For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram			
	COLOUR SHADE	<input checked="" type="checkbox"/> BLUE (RAL 5012) <input type="checkbox"/>			
	PAINT TYPE (## Refer Notes)	<input checked="" type="checkbox"/> ENAMEL <input type="checkbox"/> EPOXY <input type="checkbox"/>			
	SHAFT RPM	BIDDER TO SPECIFY			
	OLR SET VALUE	BIDDER TO SPECIFY			
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY			
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY			
	@ PWR SUPP TO MTR / STARTER	415V, 3PH,3 wire, 50Hz AC			
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER <input type="checkbox"/> 230 V <input type="checkbox"/> 110 V			

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-SS-394-145-1007			
			VOLUME		II B	
			SECTION		D	
			REV. NO.	00	DATE: 01.08.13	
			SHEET	2	OF	3
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	<input type="checkbox"/> IP 67 <input type="checkbox"/> FLAME PROOF				
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B				
	@ WINDING TEMP PROTECTION	<input checked="" type="checkbox"/> THERMOSTAT (3 Nos.,1 IN EACH PHASE) <input type="checkbox"/> -----				
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED				
INTEGRAL STARTER	INTEGRAL STARTER	<input checked="" type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	TYPE OF SWITCHING DEVICE	<input checked="" type="checkbox"/> CONTACTORS <input type="checkbox"/> THYRISTORS				
	TYPE	<input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> SMART (NON-INTRUSIVE)				
	IF SMART					
	a) SERIAL LINK INTERFACE	<input type="checkbox"/> INTEGRAL <input type="checkbox"/> FIELD MOUNTED				
	b) SERIAL LINK PROTOCOL	<input type="checkbox"/> FOUNDATION FIELD-BUS <input type="checkbox"/> PROFI-BUS <input type="checkbox"/> DEVICE NET <input type="checkbox"/>				
	c) SERIAL LINK MEDIA	<input type="checkbox"/> TWISTED PAIR Cu-CBL <input type="checkbox"/> CO-AXIAL Cu-CBL <input type="checkbox"/> OFC				
	d) HAND HELD PROGRAMMER	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	e) TYPE OF HAND HELD PROGRAMMER	<input type="checkbox"/> BLUETOOTH <input type="checkbox"/> INFRARED <input type="checkbox"/>				
	f) MASTER STATION	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	g) MASTER STN INTRFACE WITH DCS	<input type="checkbox"/> MODBUS <input type="checkbox"/> TCP/IP				
	h) DETAILS OF SPECIAL CABLE	<input type="checkbox"/> ENCLOSED <input type="checkbox"/> NOT REQUIRED				
	STEP DOWN CONT. TRANSFORMER	<input type="checkbox"/> REQUIRED				
	OPEN / CLOSE PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	STOP PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	INDICATING LAMPS	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	LOCAL REMOTE S/S	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	STATUS CONTACTS FOR MONITORING	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED				
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)				
	INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	<input checked="" type="checkbox"/> INTERPOSING RELAY <input type="checkbox"/> OPTO COUPLER <input type="checkbox"/> EITHER			
QUANTITY		<input checked="" type="checkbox"/> 2 NOs. <input type="checkbox"/> 3 NOs.				
DRIVING VOLTAGE		<input checked="" type="checkbox"/> 20.5 – 24V DC <input type="checkbox"/> _____ V DC				
DRIVING CURRENT		<input checked="" type="checkbox"/> 125mA MAX <input type="checkbox"/> _____ mA MAX				
LOAD RESISTANCE		<input checked="" type="checkbox"/> > 192 ohms - <25 k ohms <input type="checkbox"/> > _____ ohms - < _____ ohms				
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY				
	OPEN / CLOSE	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos. / <input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos				
	CONTACT TYPE	2 NO + 2 NC				
	RATING	5A 240V AC AND 0.5A 220V DC				
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE				
	ACCURACY	+3% OF SET VALUE				
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY				
	OPEN : INT : CLOSE	<input checked="" type="checkbox"/> 1 No <input type="checkbox"/> 2 Nos. 2 Nos. (ADJ.) <input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos.				
	CONTACT TYPE	2 NO + 2 NC				
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC				

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-394-145-1007		
		VOLUME	II B	
		SECTION	D	
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		SHEET	3	OF 3

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
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POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	<input checked="" type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	<input type="checkbox"/> ELECTRONIC (2 WIRE) R/I CONVERTER <input checked="" type="checkbox"/> ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	<input checked="" type="checkbox"/> 24V DC <input type="checkbox"/>	
	OUTPUT	<input checked="" type="checkbox"/> 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC, 1 PH., 50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ <input type="checkbox"/> IP 68 @ <input type="checkbox"/>	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET (9 PIN) (FOR COMM, LS/TS FEED BACK, PoT)	<input checked="" type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED <input checked="" type="checkbox"/> 2 NOS. <input type="checkbox"/>	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----	
	@ SPACE HEATER CABLE GLAND	SIZE:-----	
	OTHER CONTROL CABLE GLANDS-1	<input type="checkbox"/> 1No. for BFV of CW PUMP (Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE :-----	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

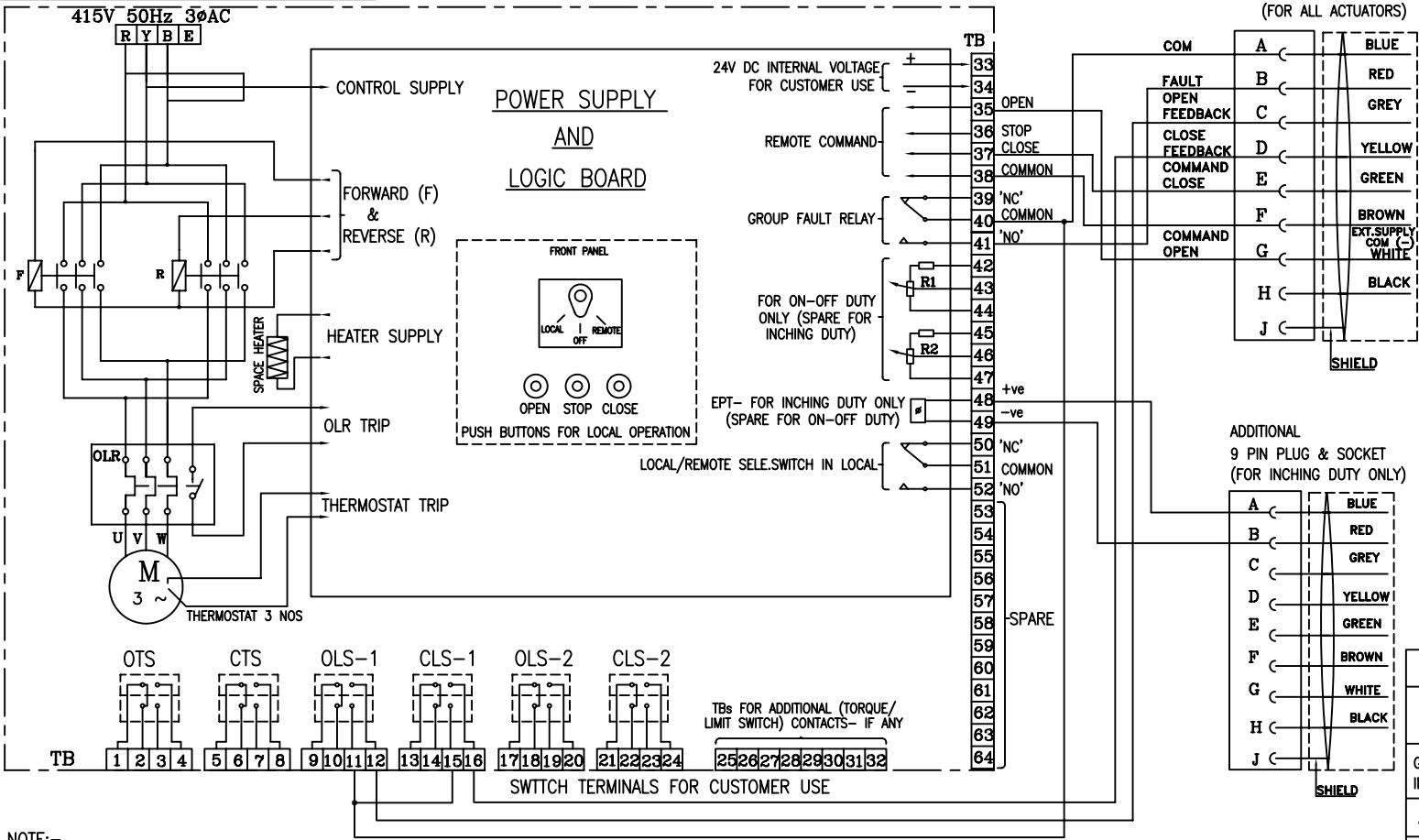
NOTES:

- 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.**

NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
	ANUJ WADHWA	CHETAN MALIK	M.A.MANSOORI	NAME
	20.06.2013	20.06.2013	20.06.2013	SIGNATURE
				DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES

DRAWING NO. 3-V-MISC-24283



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL					
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL					
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL					
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL					
OLS-1	9-10	---					
	11-12	---					
CLS-1	13-14	---					
	15-16	---					
OLS-2	17-18	---					
	19-20	---					
CLS-2	21-22	---					
	23-24	---					
SWITCH	TERMINAL NO.	Full OPEN	a	INTERMEDIATE	b	Full CLOSE	
		VALVE POSITION					
		INDICATES CONTACT CLOSED					
		INDICATES CONTACT OPEN					

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE 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
 - CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
 - OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
 - 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

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TYPE OF PRODUCT ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
OR NAME OF FOR NTPC PROJECTS
CUSTOMER/PROJECT (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

	DRN N.P.ESWAR	SIGN N.P	DATE 17.03.05	NO. OF VAR.
	CHD D.DINAKARAN	D.D	17.03.05	
	APPD K.ARUNACHALAM	K.A	17.03.05	

DEPT VL	SCALE NTS	WEIGHT (KG).	REFERENCE INFORMATIONS	NO. OF ITEMS
CODE				

TITLE WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET FOR NTPC PROJECTS	CARD CODE U 01	DRAWING NO. 3-V-MISC-24283 Page 259 of 402	REV 0
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**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT
2 X 800 MW NTPC GADERWARA STPP STAGE-I**

SPEC NO. PE-TS-394-168-A001

VOLUME-IIB

SECTION

REV.NO.0

DATE

SHEET

LIGHTING

LIGHTING	
1.00.00	GENERAL
1.01.00	This specification covers the general description of design, manufacture and construction features, testing, supply, installation and commissioning of the Lighting system equipment.
2.00.00	CODES AND STANDARDS
2.01.00	All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.
2.02.00	Lighting Fixtures and Accessories
	IS:1913 General and safety requirements for luminaires.
	IS:2148 Flame proof enclosures of electrical apparatus.
2.03.00	Lighting Panels, Switch-boxes, Receptacles and Junction Boxes
	IS:2147 Degree of protection provided by enclosures for low-voltage switchgear and control gear.
2.04.00	Electrical Installation Practices & Miscellaneous
	IS:1944 Code of practice for lighting of public thorough fare
	IS:3646 Code of practice for interior illumination.
	IS:5572 Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation
	IS:6665 Code of practice for industrial lighting.
	National Electrical Code
	Indian Electricity Rules.
	Indian Electricity Act

3.00.00

DESIGN PHILOSOPHY

1. A comprehensive illumination system shall be provided for the Hydrogen plant
2. All lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.
3. In the Off site area / buildings DC lighting shall be provided by self-contained 4hours duration Emergency lighting fixtures. Each shall be provided with Ni-cd battery, battery Charger & 2x10 W fluorescent lamps
4. The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting. The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described in chapter of LT Switchgear. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings.
5. The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The diffusers/ louvres used in fluorescent fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period.
6. Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design for fluorescent fixtures located in non air conditioned area. Similarly the correction factor towards ageing of lamps , as recommended by the lamp manufacturer shall also be considered in the lighting design.

(a)	Office area air conditioned	:	0.8
(b)	Office area non air conditioned and other indoor area	:	0.7
(c)	Dust prone and outdoor area	:	0.6
7. All outdoor fixtures shall be weather proof.
8. Wires of different phase shall normally run in separate conduit.

	<p>9. Power supply shall be fed from 415V normal AC supply, through suitable number of conveniently located lighting panels (LP). AC lighting supply shall be isolated from main supply by 2X100 % isolation transformers of rating 50KVA/100KVA for 10/15 nos. outgoing feeder with changeover switch facility. The isolation transformer shall be fed from two different bus sections of MCC. Fault level shall be restricted to 3 KA at Lighting Panels.</p> <p>10. Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. 20A, 240V AC industrial receptacle with switch shall be provided strategically in all industrial area. Suitable number of 63A,3ph., 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m. Atleast one 63A,3ph.,415V AC receptacle shall be provided in each off site building.</p> <p>11. Average lux level of 150 lux shall be maintained in hydrogen plant and 20 lux shall be maintained in outdoor areas. The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group-IIC as per IS:2148 or Class-I division-II as per NEC.</p>
3.01.00	<p>Ballasts</p> <p>(a) All HPSV and HPMV lamp fixtures shall be provided with wire-wound ballasts. All fluorescent fixtures except for Class-I, Div-IIC fittings/ increased safety fittings (Div-II/Hazardous Area) installed area shall be provided with electronic ballasts.</p>
3.02.00	<p>All luminaires and their accessories and components shall be of type readily replaceable by available Indian makes.</p>
3.03.00	<p>Fans & Regulator</p> <p>Ceiling Fans, to be provided in non air conditioned office/control room area, shall be suitable for operation on 240 V+/- 10%, 50 Hz, AC supply comprising of class 'E' insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced Aluminum blades (3 Nos.), down rod, die cast aluminum housing, capacitor, suspension hook, canopies etc. finished in stove enameled white. Power factor of fans shall not be less than 0.9. Each fan shall cover approximately 10sq.m. area.</p>
3.04.00	<p>Switch Box</p> <p>Switch boxes shall be made of 1.6 mm thick, MS sheet with 3 mm. thick decorative, perspex cover. Switchbox shall be hot dip galvanised</p>

3.05.00	Junction boxes
3.05.01	Junction box for lighting fixtures shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanised.
3.06.00	Conduits, Fittings & Accessories
3.06.01	Galvanised heavy duty steel conduits for normal area and galvanised heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered.
3.06.02	<p>Rigid Steel Conduits</p> <p>(a) Rigid steel conduits shall be heavy duty type, hot dip galvanised conforming to IS : 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside.</p>
3.06.03	<p>Flexible Steel Conduits</p> <p>Flexible conduit shall be water proof and rust proof made of heat resistant lead coated steel.</p>
3.06.04	<p>Pull-out Boxes</p> <p>Pull out boxes shall be provided at approximately 4 (four) metre interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, Structures, etc. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP :55 degree of protection and those used indoor shall be suitable for IP :52 degree of protection. Pull out box & its cover shall be hot dip galvanised.</p>
3.07.00	<p>Lighting Wires</p> <p>Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminum wire for fixed wiring installation. colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R,Y,B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper and 4 sq.mm. for aluminum.</p>
4.00.00	TESTS
4.01.00	All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the

<p>4.02.00</p> <p>4.03.00</p> <p>4.04.00</p> <p>4.05.00</p> <p>4.06.00</p> <p>4.07.00</p> <p>4.07.01</p> <p>4.07.02</p>	<p>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.</p> <p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p> <p>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.</p> <p>The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design change". Minor changes if any shall be highlighted on the endorsement sheet.</p> <p>Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S</p> <p>Type test reports of the following items as per relevant standards shall be submitted for approval.</p> <table border="0"> <thead> <tr> <th style="text-align: left;">SL NO.</th> <th style="text-align: left;">DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>i.</td> <td>Lighting panel of each type (Degree of Protection)</td> </tr> <tr> <td>ii.</td> <td>Junction Box of each type</td> </tr> <tr> <td>iii.</td> <td>Receptacles of each rating (Degree of Protection)</td> </tr> </tbody> </table> <p>Acceptance Test and Routine Test</p> <p>All lighting fixtures, lamps and other items shall be subjected to acceptance and routine test, as per relevant specified standards.</p> <p>Junction boxes, switch boxes, receptacle enclosure etc. shall be subjected to physical and dimensional checks.</p>	SL NO.	DESCRIPTION	i.	Lighting panel of each type (Degree of Protection)	ii.	Junction Box of each type	iii.	Receptacles of each rating (Degree of Protection)
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4.08.00

Galvanizing Tests

4.08.01

The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.

4.08.02

In addition following tests shall be conducted as acceptance tests.

- (a) Uniformity of coating - The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
- (b) The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually.
- (c) In addition, the plating thickness shall be determine microscopically/chemically or electronically.