1 X 500 MW FEROZE GANDHI UNCHAHAR THERMAL POWER PROJECT STAGE-IV

TECHNICAL SPECIFICATION FOR

HYDROGEN GENERATION PLANT

SPECIFICATION NO: PE-TS-401-168-A001 (REV 00)

VOLUME –II & III

BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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SECTION - A
SCOPE OF ENQUIRY

1.0 SCOPE OF ENQUIRY

This specification is intended to cover design, engineering, manufacture, inspection, testing at manufacturer's works, supply/delivery duly packed at site including freight, unloading, storage and handling at site, erection and commissioning, trial run at site, Demostration test ,obtaining CCE approval and plant handing over to customer etc. inclusive of all prevailing taxes, duties and other levies of HYDROGEN GENERATION PLANT complete with all accessories including start up mandatory and commissioning spares as required for **1X500 MW, UNCHAHAR THERMAL POWER PROJECT STAGE-IV.**

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the vendor from the responsibility of providing such facilities to complete the supply and erection & commissioning of Hydrogen Generation Plant.

1.3 Items though not specifically mentioned but needed to make the system complete as stipulated under these specifications are also to be furnished unless otherwise specifically excluded.

1.4 It is not the intent to specify all the details of the design & manufacture. However, the equipment shall be of proven design and conform in all respect to high standard of design, engineering & workmanship and shall be capable of performing the required duties in a manner acceptable to Engineer / Owner, who will interpret the meaning of drawing & the specification & shall be entitled to reject any work or material, which is not in full accordance herewith.

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

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory/ conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under VOL-III of the specification during Pre-bid clarification stage. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/ Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication to BHEL/ NTPC

1.7 Deviations along with cost of withdrawal (positive or negative), if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with tender specification & there is no deviation. (Price to be given in sealed envelope only).

1.8 Bidder to note that the terms "Owner", "Customer" or "End-user" used anywhere in this technical specification essentially means the end-user of the project or his assigned consultant.

SECTION – B

PROJECT INFORMATION

Annexure-IB

CLAUSE NO.	PROJECT INFORMATION 11748 एनटीपीसी NTPC
1.00.00	**BACKGROUND**
	Feroze Gandhi Unchahar Thermal Power Station, FGUTPS was conceived as a Load Centre coal based Power Station of 1050 MW capacity by UPSEB. The land for the project was acquired and stage-I (2x210MW) was implemented by UPSEB. The 2x210 MW Unchahar station was taken over by NTPC from Uttar Pradesh Rajya Vidyut Utpadan Nigam of Uttar Pradesh in 1992. Thereafter, NTPC implemented Stage- II (2x210 MW) and Stage-III (1X 210 MW).
	The present expansion proposal is to install one additional unit of 500 MW under Stage-IV thus making the ultimate capacity of the FGUTPP 1550 MW.
1.01.00	**LOCATION AND APPROACH**
	The plant is located in Raebareli district of Uttar Pradesh, having latitude and longitude of 25°54'50"N and 81°19'50"E respectively. It is bounded by villages Khnapur, Faridpur and Khaliqpur Khurd. Mustafabad town is located at a distance of about 3 Kms from the plant. Unchahar railway station on Allahabad-Raebareli broad gauge (BG) section of Northern Railway (NR) is 2 Kms away. The nearest airport is located at Lucknow a distance of approximately 110 km from the project site.
	Vicinity Plan of the project is placed at **Annexure-I**
1.02.00	**LAND REQUIREMENT**
	During the implementation of FGUTPS, Stage-I, II & III total area of about 2203 acres of land was acquired. The plant facilities, ash disposal and township for this expansion Stage-IV (1x500 MW) would be accommodated within the available land with dismantling and relocation of some buildings. No additional land has been envisaged to be acquired for this expansion project.
1.03.00	**WATER**
	As per agreement between NTPC & Irrigation department, 105 Cusec of water is supplied through S.S Canal to NTPC-Unchahar. The Stage-IV (500MW) consumptive water requirement shall be accommodated within the existing commitment of water to FGUTPP. Sharda sahayak canal and Dalmau Pump House (DPH) on Purwa Branch Canal are available sources of water for the project and therefore, the make up water requirement for the plant is proposed to be drawn from these sources.
1.04.00	**COAL AVAILABILITY AND TRANSPORTATION**
1.04.01	**Coal Availability**

BHEL POWER PROJECTS PRIVATE LIMITED NTPC NBPPL

The coal requirement shall be about 2.7 Million tonnes per year.

The matter has been taken up with Ministry of Coal, Govt. of India for Long Term Coal Linkage for Stage-IV (1x500 MW)..Coal requirement for FGUTPP, Stage-I ,II & III is being met from North Karanpura Coal fields of CCL. For FR purposes, coal from North Karanpura Coal fields of CCL has been considered.

1.04.02 **Coal Transportation**

The envisaged mode of coal transportation from the coal mines to the power plant is by Indian Railways rakes. The rakes shall be unloaded at the track hopper.

1.04.03 **Coal Quality Parameters and Fuel Oil Characteristics**

The Coal quality parameters and Fuel Oil Characteristics are enclosed as **Annexures-II-1 and II-2** to this subsection.

1.05.00 **CAPACITY & POWER EVACUATION**

Stage- I	:	2x210 MW	Under Commercial Operation
Stage-II	:	2x210 MW	Under Commercial Operation
Stage-III	:	1x210 MW	Under Commercial Operation
Stage-IV		1x 500 MW	Present proposal

The existing capacity of plant is 1050 MW Step up/ power evacuation voltage for station is 220 KV. Presently 1000 MW is already being evacuated at 220 KV, addition of another 500 MW at 220 KV may cause overloading of 220 KV systems and lead to increase in fault levels at 220 KV system. Considering this 400 KV has been considered as step-up/power evacuation voltage for Stage-IV. Power Generated from FGUTPP- Stage IV, 500 MW unit would be stepped up to the evacuation voltage level through suitably rated Generator Transformer.

The power generated from Stage-IV is envisaged to be absorbed by Northern Region beneficiaries. For finalisation of Associated Transmission System (ATS) of the project, the matter would be taken up with Power Grid Corporation of India Ltd. (PGCIL)/CEA/appropriate authority depending on the various routes/options of power sale envisaged for the project.

1.06.00 **METEOROLOGICAL DATA**

Important meteorological data from nearest observatory at **Allahabad** is placed at **Annexure - III.**

1.07.00 **PLANT WATER SCHEME**

CLAUSE NO.	PROJECT INFORMATION 11750 एनटीपीसी NTPC
	The Plant water scheme is described below.
1.07.01	**Source of Water** The source of water for the project is normally from the Allahabad branch canal of the Sharda Sahayak link canal. During the canal closure period, water will be drawn from the Dalmau canal.
1.07.02	**Water Requirement** Normal Make up water requirement for this project would be about 2000 Cu.M/hr with ash water re-circulation system in operation. However, whenever ash water system needs to be operated in once thru mode, water drawl shall be of the order of 3300 cum/hr.
1.07.03	**Raw Water System** Raw water shall be drawn from the source by a gravity channel upto raw water pump house located inside the plant. It is envisaged to provide three (3) numbers (3 x 50 % Capacity) of raw water pumps for supplying water to Water PT Plant in the raw water pump house. In addition two (2) numbers (2 x 100% capacity) of pumps shall be provided to supply raw water for ash handling plant which shall be operated as and when required. Separate set of pipelines of carbon steel construction shall be provided from respective raw water pumps to Water treatment plant and Ash Water tanks.
1.07.04	The quality of Raw water and Clarified water is enclosed with this sub-section
1.08.00	**Criteria for Wind Resistant Design of Structures and Equipment** All structures and equipment of the power plant, including plant auxiliary structures and equipment, shall be designed for wind forces as given in Sub-Section- D-01, Part-B, Section-VI, i.e. Technical Specification for Civil and Structural Works.
1.09.00	**Criteria for Earthquake Resistant Design of Structures and Equipment** All power plant structures and equipment, including plant auxiliary structures and equipment shall be designed for seismic forces as given in Sub-Section- D-01, Part-B, Section-VI, i.e. Technical Specification for Civil and Structural Works.

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SECTION – C1

SPECIFIC TECHNICAL REQUIREMENT (MECHANICAL)

GENERAL:-

This specification is intended to cover design, engineering, manufacture, inspection, testing at manufacturer's works, supply/delivery duly packed at site including freight, unloading, storage and handling at site, erection and commissioning, trial run at site, Demonstration test ,obtaining CCE approval and plant handing over to customer etc. inclusive of all prevailing taxes, duties and other levies of HYDROGEN GENERATION PLANT complete with all accessories including start up, mandatory and commissioning spares as required for **1X500 MW, UNCHAHAR THERMAL POWER PROJECT STAGE-IV.**

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

A) Major Mechanical scope:-

1. Two streams of electrolysers working in parallel (each of capacity minimum 5 Nm3/hr.).
2. Three (3) numbers of hydrogen gas compressors and drives (each of minimum capacity 6.25 Nm3/hr) with cell purging system, mixing tank, DM tank, pumps to handle electrolyte and its filters, gas washing system, two gas holders each of minimum capacity 5 m3 for unipolar design.
3. De-oxy units , coolers, hydrogen gas purification system, filling manifold, piping fitting, valves, 8 number empty hydrogen cylinders, 8 numbers empty nitrogen cylinders complete with required instrumentation and other items as per P&ID for the hydrogen generation plant enclosed with this technical specification.
4. Bidder shall include vacuum pump and high-pressure cylinder testing apparatus along with all accessories for testing cylinders.
5. Bidder to note that the instrument air / service air shall be terminated at a distance of 10m from the hydrogen plant building. Further distribution shall be in bidder's scope
6. Bidder to include the Ventilation Requirement for hazardous and non-hazardous area including toilets in his scope for the H2 Plant building as per the requirement specified in the clause number 4.00.00, section D1 of technical specification.

7. Feed water / Cooling water:

FEED WATER: - Bidder shall be given DM water for hydrogen generation and cooling purpose (at the required rate at 1 kg/cm2 (min) at one point near hydrogen generation plant building (10m). Further distribution shall be in bidder's scope. The DM Water analysis is attached with this technical specification in Annexure-1.

COOLING WATER: - Service water shall be used as cooling water and shall be terminated at a distance of 10m from the hydrogen plant building at ambient temperature and pressure of 1 kg/cm2 (min) and the same may be used as cooling water. The Service Water analysis is attached with this technical specification in Annexure-2. If the bidder finds the analysis of service water is not suitable for their system, bidder shall provide closed loop cooling with passivated DM water as make up. Bidder to include in his scope all the equipment and accessories required for closed loop cooling and passivation of DM water. Bidder shall indicate DM water make up requirements in the technical offer in case they adopt closed loop cooling with passivated DM water. Further distribution of cooling water to cells, compressor & other auxiliaries within the plant shall be in bidder's scope.

8. Start-up and commissioning spares as required.
9. Mandatory spares as listed in section-C1 of this technical specification.
10. Embedment plates with lugs shall also be provided by bidder as per system requirement.
11. All channels & brackets, mounting plates as required for mounting of motors, pumps, tank etc. shall be in bidder's scope.

12. All auxiliary steel structure (U-clamps, nuts, bolts, conducts, Hangers and supports, channels etc.) for fixing pipes shall be in bidder's scope.
13. All necessary flanges and counter flanges to interconnect the pipes.
14. Any item/work either supply of equipment or erection material which have not been specifically mentioned in but are necessary to complete the woks for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification and shall be in bidder's scope and will be supplied by bidder without any commercial, technical and delivery implication to BHEL/Customer.
15. All required elbow, tee, pipe fittings etc. required for erection of the complete system including piping shall be in bidder's scope.
16. All drains shall be terminated at point in hydrogen generation plant building.
17. Bidder shall also provide connection, isolation device, manifold, piping etc. for N2 gas connection to cell system for purging.
18. Bidder to note that N2 gas required for purging the system during commissioning/Demonstration test/trial operation etc. till handing over the plant to CUSTOMER shall be arranged by bidder.
19. Bidder shall also obtain the necessary clearances etc. from Govt. Agencies for the Hydrogen Generation plant. Hydrogen generation and storage system shall comply with all applicable federal state laws, and local ordinances.
20. Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements for successful running of hydrogen Generation plant.
21. **Electrical scope:-**

    1. The scope of electrical works, equipment and services shall be as per table for electrical scope between BHEL and vendor enclosed in Annexure – 4, section C2 of technical specification.

    2. Constant speed Sq. cage type Electric motor shall be suitable for group IIC of IS 2148 which is equivalent to Class-I Div.II of NEC.

    3. The other electrical design requirement shall be as specified in section D2 of technical specification.
22. **Control and instrumentation scope:-**

    1. All necessary instruments such as transmitters/temperature elements/sensors/switches/gauges etc. shall be provided for safe, efficient & reliable operation and maintenance of the H2 generation plant. All instrument devices shall be provided with explosion proof enclosure as described in NEC (USA) Article 500, Class – I, Div. I or to provide suitable type zener barriers of standard approved make meeting the requirements as approved by chief controller of explosives, India and other statutory authorities.

    2. The control of hydrogen generation plant shall be dual processor based PLC system, PLC unit shall be provided with two processors (main processing unit and memories) one for normal operation and one as cold standby.

    3. The PLC system shall be provided with necessary interface hardware and software for dual fiber optic connectivity and interconnection with station wide LAN (In employer's scope) for two-way transfer of signal for information sharing only of hydrogen generation plant. The plant information shall be made through either net link following TCP / IP standard. The system shall be OPC compliant. The dual fiber optic communication cable between bidders control panels and employer's DDCMIS is excluded from bidder's scope. However bidder shall include accessories required at PLC end for connectivity to other systems.

    The other control and instrumentation design requirement shall be as specified in section D3 of technical specification.
23. **Civil scope:-**

    All civil works including building & foundation of equipment are excluded from bidder's scope. However, bidders to note that complete grouting of the equipment, fixing etc. shall be in the scope of bidder. Bidder shall furnish all applicable civil inputs details during detailed engineering.

24. **COMMISSIONING SPARES**

All the necessary commissioning spares shall be supplied as a part of base offer. Bidder will submit the list of commissioning spares for hydrogen generation plant along with the offer.

25. RECOMMENDED SPARES

Bidder to submit the list of recommended spares for 3 years of operation & maintenance along with the offer.

26. **QUALITY ASSURANCE PLANS**

Bidder to note the QP requirement shall be inline with the section C1 of technical specification. However, detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be decided during detailed engineering. All inspection & testing etc. shall be carried out accordingly. Any changes/additional tests insisted upon by Owner during detailed engineering shall be accepted by bidder without any commercial implication to BHEL/Owner.

27. **SUB VENDOR:-**

Bidder to note the sub vendors shall be selected from the sub vendor list enclosed in section C1 with the technical specification. Additionally proposed sub vendor over and above specified in the enclosed list shall be subjected to BHEL / Customer approval during detailed engineering without any commercial / delivery implication to BHEL / Customer. Requirement of detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be finalized during detailed engineering stage; decision of BHEL/Owner shall be binding on vendor in this regard.

28. DEMONSTRATION TEST:-

Bidder shall demonstrate parameters enclosed in section D1 of technical specification requirement to the satisfaction of Owner. The exact modalities for the parameters indicated in the specification shall be finally as agreed with the Owner during detailed engineering & mutually agreed. The Bidder shall arrange all the monitoring gadgets / instruments / equipment required for demonstrate parameters. Site facility as available or as extended by Owner shall only be provided.

29. TERMINAL POINTS

Feed water / Cooling water:

TP1:- Bidder shall be given DM water for hydrogen generation and cooling purpose (at the required rate at 1 kg/cm2 (min) at one point near hydrogen generation plant building (10m). Further distribution shall be in bidder's scope.

TP2:- Service water shall be used as cooling water and shall be terminated at a distance of 10m from the hydrogen plant building at ambient temperature and pressure of 1 kg/cm2 (min) and the same may be used as cooling water. If the bidder finds the analysis of service water is not suitable for their system, bidder shall provide closed loop cooling with passivated DM water as make up. Bidder to include in his scope all the equipment and accessories required for closed loop cooling and passivation of DM water. Bidder shall indicate DM water make up requirements in the technical offer in case they adopt closed loop cooling with passivated DM water. Further distribution of cooling water to cells, compressor & other auxiliaries within the plant shall be in bidder's scope.

Note:- Bidder to note that the temperature of feed water / cooling water at terminal point 1 and 2 shall be as per ambient conditions.

TP3, Drains:- All drains shall be terminated at one point by bidder.

TP4, Air:- the instrument air / service air shall be terminated at a distance of 10m from the hydrogen plant building. Further distribution shall be in bidder's scope

30. **Painting:**

Bidder to note that hydrogen generation plant painting for the imported items shall be as per manufacturer standard practices The painting of the indigenously supplied equipment shall be as per the section C1 of technical specification only. The color-coding for hydrogen generation plant shall be decided during detailed engineering.

31. **DRAWINGS/DOCUMENTATION**

Drawing/documents requirement (No. of hard copies/CD-ROM/floppies) shall be as stated drawing document distribution schedule, section C1 of technical specification. Bidder to note that all the drawings/documents including Process & instrumentation diagram, layout, piping, equipment data sheet, foundation drawing, control & instrumentation, general arrangement drawings, field quality plan, quality plan, erection drawings, O&M Manual, Demonstration procedure, plant control philosophy etc. as per document list enclosed in the specification shall be submitted for approval of BHEL/Owner during detailed engineering. In case any change is suggested by Owner to meet the system/specification requirement, the same shall be incorporated / carried-out without any commercial/delivery implication to the satisfaction of Owner/BHEL.

32. POWER LOADING CRITERIA:-

S. No	Description	Nabinagar
1	Rate of loading during evaluation	US $ 2,981
2	Rate of penalty during PG test	US $ 2,981

Note 1: - Bidder to note that 1/3 (33%) of power consumption quoted by bidder (power consumption for electrolyser and compressor of one stream of the hydrogen generation plant) shall be used for evaluation and penalty purpose.

Note 2: - Bidder shall submit format for guarantee power consumption in the format attached in, section-C1, duly filled-in all respects along with the priced bid.

Note-3:- Evaluation shall be done w.r.t the base power consumption of 45 KW, (Total power consumption of one stream). The net differential loading amount (worked out in the following manner) will be added with respective bidder's total quoted price to derive the total price for evaluation.

(Total Power consumption of one stream quoted by the bidder-45)/3*US$ 2981.

Note-4:- In case the successful bidder fails to establish/ prove the guaranteed values of power consumption on actual performance testing at the manufacturing works/ site, penalty by above indicated figure in s.no.2 by 1/3 of per increases in KW, power consumption shall be levied.

ANNEXURE-1

SL.NO	Characteristics	Value
1.	Silica (Max.)	0.02 ppm as SiO_2
2.	Iron as Fe	Nil
3.	Total hardness	Nil
4.	pH value	6.8 – 7.2
5.	Conductivity	Not more than 0.1 excluding the effects of free CO_2

ANNEXURE-2

DESIGN CLARIFIED WATER ANALYSIS FOR DM PLANT

S.No	Constituent	As	mg/l
1	Calcium	CaCo3	135.2
2	Magnesium	CaCo3	95
3	Sodium+ Potassium	CaCo3	130
4	Total cations	CaCo3	360.2
5	Bicarbonates	CaCo3	245.7
6	Chloride	CaCo3	57
7	Sulphate	CaCo3	57.5
8	Total Anions	CaCo3	360.2
9	Silica	As SiO2	12
10	Iron	Fe	0.3
11	pH Value	-	7.0-8.2
12	Turbidity (NTU)	NTU	10

ANNEXURE-3

GUARANTEED PERFORMANCE DATA

SL. NO.	Description	Parameter
1	Hydrogen generation plant minimum capacity (Nm3/hr.)	10
2	Number of streams (2X50%)	2
3	Minimum Capacity of each streams/electrolyser (Nm3/hr.)	5
4	Hydrogen purity (%) at gas manifolds	99.9
5	Moisture content - gm/m3 (max)	0.05
6	Design delivery pressure at its rated duty point Kg/cm2 (g)	150
7	Minimum capacity of each compressor (Nm3/hr.)	125% of rated Capacity of each streams/electrolyser (Nm3/hr.)
8	Vibration level of compressor	As per internationally accepted standard
9	Noise level of compressor	85 dBA (to a reference of 0.0002 micro bar).

QUALITY PLAN

HYDROGEN GENERATION PLANT

HYDROGEN GENERATION PLANT-TESTS

Items / Components \ Tests/Check	Material Test	WPS/PQR/Welder	DPT/MPI	Ultrasonic test	RT	Pneumatic test	Hydraulic / Water Fill tests	Assembly / fit up	Dimension	Functional/ operational tests	Performance tests	Other tests	Remarks
H2 PLANT													
A.COMPRESSOR								Y		Y	Y		
1) Casing	Y^3												
2) Crank shaft/connecting rod	Y^3		Y	Y					Y				
3) Piston/Diaphragm			Y^3							Y			
B. DRYING PLANT							Y						
1.)Raw material identification	Y^3		Y^1		Y^2								
C. HYDROGEN GENERATOR							Y			Y	Y		
D. CELL MODULE							Y			Y	Y		
E. GAS HOLDER	Y^3						Y						

1.Fillet welds/nozzles welds and knuckle portion of dished ends and all butt welds.

2. 100% butt welds and 100% for Tee joints and dished ends welds.

3. One per heat /HT batch.

Notes.

1.Quantum of checks shall be 100% unless otherwise specified.

CLAUSE NO.	QUALITY ASSURANCE	एनटीपीसी NTPC

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test (R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD(IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note: **1) Detailed procedure of Environmental stress screening test shall be as per Quality Assurance Programme in General Technical Conditions**

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y*	Y	Y**	Y**			Y	Y**	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y*	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) Detailed procedure of Environmental stress screening test shall be as per Quality Assurance Programme in General Technical Conditions.

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

CLAUSE NO.	QUALITY ASSURANCE	एनटीपीसी NTPC

CONTROL PANEL SQE_25

Attributes / Characteristics Item Components / Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness	Mountings / BOM/ Make, Completeness / Wiring	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Specification requirement
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contractor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
LVS, Mosaics														Y
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
Control panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.

PROCESS CONNECTION AND PIPING

TESTS / ITEMS	Visual ®	GA, BOM, Layout of component & construction feature®	Dimension ®	Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices ®	Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y	Y	Y*		Y		Y	Y								
Gauge Board	Y	Y	Y	Y		Y		Y		Y			Y	Y			
Impulse pipes and tubes	Y		Y		Y			Y							Y		
Socket weld fittings ANSI B-16.11	Y		Y					Y							Y		Y
Compression fittings	Y		Y					Y						Y	Y	Y	
Instrument valves & Valve manifolds	Y		Y					Y						Y	Y		
Copper tubings ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.

Note: R-Routine Test A- Acceptance Test Y – Test applicable

Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

CLAUSE NO.	QUALITY ASSURANCE	एनटीपीसी NTPC

INDUCTION MOTOR & SYNCHRONOUS MACHINE

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y	Y		Y		
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD,CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y						
Motor (IS 325 / 4722/ 9283)	Y	Y	Y						

08992

INDUCTION MOTOR & SYNCHRONOUS MACHINE

TESTS/CHECKS / ITEMS/COMPONENTS	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All routine & acceptance tests as per IS-325/IS-4722 /IS-9283/IS 2148/IEC 60079-I	vibration	Over speed	Tan delta, shaft voltage & polarization index test
Plates for stator frame, end shield, spider etc.									
Shaft									
Magnetic Material	Y		Y						
Rotor Copper/Aluminium									
Stator copper			Y						
SC Ring									
Insulating Material			Y						
Tubes for Cooler		Y							
Sleeve Bearing		Y							
Stator/Rotor, Exciter Coils									
Castings, stator frame, terminal box and bearing housing etc.									
Fabrication & machining of stator, rotor, terminal box									
Wound stator									
Wound Exciter									
Rotor complete				Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly									
Accessories, RTD, BTD,CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.									
Motor (IS 325 / 4722 / 9283/2148/IEC 60079-I)						Y	Y	Y	Y1

Note : 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalisation. However, No QP for LT motor upto 50KW.

2. Makes of all major bought out items will be subject to NTPC approval.

Y1 = for HT Motor / Machines only.

PLC BASED CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS

PROGRAMMABLE LOGIC CONTRLLER

TESTS / ITEMS	Visual ®	GA, BOM ,Lay Out of components ®	Dimensions ®	Paint Shade/ Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ Mosaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element , Annunciation ®	Mimic ®	Test as per IEC 1131 ® *	Test as per Std ® & (A)
1. PLC Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
2. Control Desk With PLC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		

Note: **1) Detailed procedure of Environmental stress screening test shall be as per Quality Assurance Programme in General Technical Conditions**

2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure alongwith relevant supporting documents.

*Applicable for PLC Y - Test Applicable , ® - Routine Test (A) - Acceptance Test

09001

CLAUSE NO.	QUALITY ASSURANCE	एनटीपीसी NTPC

Attributes / Characteristics → / Items / Components / Sub- assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish	Complete physical examination for constructional features of Battery Charger as per NTPC specification	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^C for 48 hrs	Degree of Protection Test as per NTPC Spec.
BATTARY CHARGER													
Rectifier Transformer (IS : 2026)	Y			Y			Y				Y		
Electronic Components including Potentiometer (Vernier Type)	Y			Y									
PCB & Electronic Cards	Y			Y									
19" standard racks for electronic cards	Y					Y							
Control & Selector Switches (IS : 6875)	Y			Y						Y			
Indicating Meters (IS : 1248)	Y			Y						Y			
Indicating Lamps (IS: 13947)	Y			Y						Y			
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y			
Control Terminal Blocks (IS :13947)	Y			Y									
Control Transformer (IS : 12021)	Y			Y						Y			
Push Buttons (IS : 4794)	Y			Y						Y			
MCB (IS : 8828)	Y			Y						Y			
PVC insulated Copper control wires (IS : 694)	Y			Y									
Sheet Steel (IS : 513)	Y	Y	Y	Y									
Synthetic Rubber Gaskets	Y	Y		Y									
Annunciator	Y									Y		Y	
Battery Charger	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:1.Detailed procedure of Environmental stress screening test shall be as per Quality Assurance Programme in General Technical Conditions

2. *This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan* indicating the Practice and procedure along with relevant supporting documents.

3. Makes of all major Bought Out Items will be subject to NTPC approval.

POWER SUPPLY SYSTEM

ITEMS \ TESTS	Visual/dimension/rating/ Paint Adhesion/ Thickness (R)	General arrangement/BOM/make of components /Mimic ®	Efficiency ,regulation(R)	Input voltage variation (A)	Out put voltage and frequency adj.range(A)	Premilinary light load test(R)	Load transfer retransfer test (R) *	AC input faliure and return test (R)	Parralel operation and current divison(R)	Relative harmonic content(R)	Restart with PRI A.C and battery (separately)(R)	System transfer and retransfer (R)*	Asynchronous transfer(R)	Ripple content(R)	Load limiter operation (R)	IR/HV(R)	Tests as per standard &specification (R)&(A)
UPS/CONVERTER (IEC-146 PT-4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VOLTAGE STABILISER	Y	Y	Y	Y	Y					Y		Y				Y	
LEAD ACID BATTERY(TUBLAR)-IS-1651																	Y
LEAD ACID BATTERY (PLANTE)-IS-1652																	Y
NICKEL CADMIUM BATTERY(IS-10918/IEC-623)																	Y

R-Routine Test A- Acceptance Test Y – Test applicable

* Transfer time and Over shoot /under shoot during load & system transfer shall be recorded .

Note: 1) **Detailed procedure of Environmental stress screening test shall be as per Quality Assurance Programme in General Technical Conditions**

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

CLAUSE NO.	QUALITY ASSURANCE	एनटीपीसी NTPC

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER

Test/Attributes Characteristics / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(IS_9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: 1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

® - Routine Test (A) - Acceptance Test Y - Test applicable

CLAUSE NO.	TECHNICAL REQUIREMENTS

44.00.00

QUALITY ASSURANCE (LT BUSDUCTS)

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	LT BUSDUCT														
	Dimension & Surface Finish	Make, Type, Rating & TC	Electrical Properties	Mechanical Properties	Chemical Properties	Item to conform to relevant IS	WPS Approval, Welder Qualification	Weld Quality Check (DP test & x-ray Test)	Paint Shade, Thickness, Adhesion & Finish	Tightness by Torque measurement	Electrical Clearances	Galvanizing Test as per IS 2629/ 2633/ 4759	IR – HV – IR Test	Phase Sequence Check	Degree of Protection routine test as per NTPC spec.
Aluminum Sheets / Plates / Strips / Flexibles / tubes (IS : 5082 / 737)	Y	Y		Y	Y	Y	Y	Y							
CRCA Flats / ISMC (IS 2062)	Y	Y		Y	Y	Y									
Neoprene / Synthetic Rubber Gaskets	Y	Y		Y	Y										
Rubber Bellows (IS : 3400)	Y	Y		Y	Y										
Support Insulator	Y	Y	Y	Y											
Galvanized Structure & GI Earthing Flat (IS : 2629 / 2633 / 4749)	Y	Y				Y						Y			
Space Heater & Thermostat		Y	Y										Y		
LT Busduct (IS : 8623 PART 2)	Y	Y				Y	Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to NTPC approval.

POWER SUPPLY SYSTEM

ITEMS \ TESTS	Visual/dimension/rating/ Paint Adhesion/ Thickness (R)	General arrangement/BOM/make of components /Mimic ®	Efficiency ,regulation(R)	Input voltage variation (A)	Out put voltage and frequency adj.range(A)	Premilinary light load test(R)	Load transfer retransfer test (R) *	AC input failure and return test (R)	Parralel operation and current divison(R)	Relative harmonic content(R)	Restart with PRI A.C and battery (separately)(R)	System transfer and retransfer (R)*	Asynchronous transfer(R)	Ripple content(R)	Load limiter operation (R)	IR/HV(R)	Tests as per standard &specification (R)&(A)
UPS/CONVERTER (IEC-146 PT-4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VOLTAGE STABILISER	Y	Y	Y	Y	Y					Y		Y				Y	
LEAD ACID BATTERY (TUBLAR)-IS-1651																	Y
LEAD ACID BATTERY (PLANTE)-IS-1652																	Y
NICKEL CADMIUM BATTERY(IS-10918/IEC-623)																	Y

R-Routine Test A- Acceptance Test Y – Test applicable

* Transfer time and Over shoot /under shoot during load & system transfer shall be recorded .

Note: 1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

PEM :: C&I

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.:
VOLUME
SECTION
REV. NO.
SHEET 1 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.0	**Materials /Components**											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visual	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2	2	1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2	2	1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2	2	1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA	Visual	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2	2	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.:
VOLUME
SECTION
REV. NO.
SHEET 2 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2	2	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
2.0	**Assembly**											
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2	1	1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2	2	1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2	1	1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100%	FAT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2	2	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
3.0	**Factory Acceptance Test (FAT)**											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.
1 - BHEL 2 - Vendor 3 - Sub-vendor

LIST OF SUB VENDOR

SUB VENDOR LIST FOR HYDROGEN GENERATION PLANT	
Main Equipment	**Manufacturer/Sub-Vendor**
Hydrogen gas generator with purification system	Approved Main supplier own make
Power supply rectifier	Neeltran/Amtek/Rapid USA / Jasper/Hind
Hydrogen Compressor	PPI USA / PDC Machines INC. USA / Burton Corblin / Seybert & Rahier/Gardner Denver
PLC	OMRON, Japan / SAIA / Rock well / GE Fanuc / Seimens / Schneider/Allen Bradley, USA
Transmitters	Rosemount / Torex / Jumo / Yokogawa / Honeywell
Combustible Gas Detector	Sierra Monitor, USA / Zellweger
Trace oxygen Analyser / Hydrogen analyser	Advance Instruments USA, E&H, Yokogawa, H&B, Emerson/Edgetech
Hygrometer	GE Sensing / Miechel Instruments/VAISALA USA
Portable H2 purity Analyser	Teledyne, USA / Gesellshaft Fur Geratebau mbH
Piping Materials(SS)	Sandvik Steel Co.USA/ Ratnamani, Ahemdabad/ Remi Mumbai
Piping Materials(CS)	Maharashtra Seamless, Mumbai/Jindal, Mumbai
Tube / Pipe Fittings	SWAGELOK / PARKER USA

Feed Water Tank	Hydromax,USA/Sharpeville, USA
Annuciator/Control panel (refer note 4)	Internationally reputed make as per choice of Approvedmain supplier.
Solenoid valves	Asco,USA/ IMI Norgen Germany
Vacuum pump	Acmevac Sales Pvt. Ltd, Mumbai, India /NI Tech USA & S.Africa/Edwards Limited, UK/Gardner Denver Nash, China/Dicon, Mumbai Reputed
Hydrogen Dryer	Mellcon ENGS> PVT. LTD, New Delhi/Jindal Elect, Rourkee.
Cylinder test station	Indian compressors Limited, New Delhi, India/ Reputed
Hydrogen Filling Manifold	Misatu Weldquip Pvt. Ltd., Gujarat / Reputed
Nitrogen Manifold	Misatu Weldquip Pvt. Ltd., Gujarat / Reputed
N2 / H2 Cylinders	BPCL Allahabad India/ Everest Kanto Cylinder Ltd. India
Ventilation Equipment	khaitan / ABB / C.Doctr / Nadi,Chennai / Alsthom
Zenner Barrier	MTL / P+ F India / Reputed
Instrument Cable	Delton cables,Faridabad/paramountcables, Hhushkhera/ Reliance, banglore/Polycab, Daman/ Universal Cables, Satna/ Elkay Telelinks, New Delhi/ Cords, Bhiwadi.
415 V LT Switch gear	C&S, Noida/ Seimens LTD. Mumbai/Alstom LTD, Kolkatta/L&T Coimbatore or Munbai/ GE Indai, Banglore/ Schneider Electric India Pvt Ltd, Nasik.
Flame proof motors	KEC,_Hubli/CGL,_Ahmednagar/_Bharat_Bijli,_ Mumbai_
Compressor motors	CEMP, USA/ Lohar, Germany/ABB, Germany

LT Power Cables PVC Insulated	KEI, Bhiwadi/ Delton Cables, Faridabad/ Ravin Cables, Pune/ Cords Cables, Bhiwadi/ Polycab wires, Daman/ Radiant, Hyderabad/ UCL, Satana/ ICL, Rajpura/ HVPL, Faridabad/ Elkay Telelinks, Faridabad/ Finolex Cables, Pune/ Paramount, Alwar/ Torrent, Nadiad/ INCAB, Pune/ NICCO, Kolkata
LT Control Cables	ICL, Rajpura/ Paramount Cables, Alwar/ Radiant Cables, Hyderabad/ Polycab Wires, Daman/ UCL, Satana/Nicco, Kolkata/ FGI, Kolkata/ Torrent, Nadiad/ Cords Cable, Bhiwadi/ Elkay Telelinks, Hyderabad/ Delton Cables, Faridabad/ HVPL, Faridabad
Instrumentation cables, Special cables (Refer Note 1)	Kerpen cables, Germany/ Lapp Cables, Germany/ Thermo Electra B V, Netherlands/ Thermoelectric, USA
PVC FRLS	Reliance Engineers, Bangalore/ Polycab, Daman/ Nicco, Kolkata/ Paramount cables, Alwar/ Delton, Faridabad/ INCAB, Pune
Cable Trays & Access	Vatco, Mumbai/ Indian Perforators Unistar Galv., Kolkata/ Anand Udyog, Mumbai/ Indiana+Karamtara Galv., Mumbai/ Jamuna Metal, Delhi/ Dolphin (Fabrication by INAR), Ankapally, Stellite Engg, Mumbai/ Unitech Fabricators, Kolkata
Cable tray Flexible Support system	Stellite Engg., Mumbai/ Am Tech + BG Shirke galv., Pune/ Vatco, Mumbai/ Dolphin, Ankapally/Comet, Mumbai
Cable Glands	Sunil & Co., Kolkata/ QPIE, Kolkata/ Arup Engineering, Kolkata/ Commet, Mumbai
Lugs	Dowell, Mumbai/Chetna, Nasik
Luminaries & Lamps	CGL, Mumbai/ Philips, Kolkata/ Bajaj, Mumbai
Lighting Panel (Wall mounted)	Positronics, Baroda/ Pyrotech, Udaipur
Flame proof lighting fixtures, JB, PB	Baliga, Chennai/Ajmera, Mumbai/Flexpro, Navsari
Lighting wires as per IS 694	BIS approved source
Cooling water control Valve	Bellito Air Controls Inc., USA, Emerson France, WEIR valves, UK/ Dresser Mesonilan, France/ Copes Valcun
Pressure Transducer	Barksdale, USA/Camille Bauer, Switzerland/ Metrawatt, Germany
Valves Gate, Globe, Check (15 NB to 250 NB) (up to 2500 Class)	TOA Valves, Japan/ Deutsche Babcock, Germany/ Dresser, USA

Valves Gate, Globe, NRV (15 NB to 250 NB) (up to 800 Class)	Audco, Chennai/ BDK, Hubli
Check valves	NUPRO, USA
Level Transmitter (Displacer type)	Dresser Mesonelan, France/ Yamatake Honeywell/ Japan, ECKORDT, Germany/ Dresser, USA
Level Transmitter (Capacitance type)	Magnetrol, Belgium/ E&H, Germany
Pressure Gauges	Swagelok, USA/Alecandria WIKA, Germany/ Dresser Aschcroft, USA/ Budenburg, UK
Pressure switches, Temperature switch, DPS	NEODYN, USA/Delta, UK/ ITT Barton,USA/ KDG, UK/ Dresser,USA/ SOR, USA/Herion, Germany
Differential pressure Indicators	ITT Baron, USA/Budenburg, UK/ Switzer/ Dresser Asherroft,USA
Computers	DELL/COMPAQ/HP/LENOVO
Printers	HP/CANON/Xerox/SAMSUNG
Air Conditioner	Carrier/LG/HITACHI/BLUE STAR
Ventilation Fans	Marathon Electric/Khatan/ABB/Alstom/Bajaj

PAINTING REQUIREMENTS

(f.) Control and Instrumentation Requirements

(g.) The bidder shall supply all necessary Instrumentation for satisfactory operation of dosing system. The control of the system shall be through BOP C&I part of DDCMIS under Employer's scope.

(h.) The bidder shall supply all field instruments, devices as per the approved schemes as a minimum. These field instruments should confirm to requirements specified in the control and instrumentation section of this volume.

(i.) It is intended to control dosing system from BOP C&I part of DDCMIS (under Employer's scope), including ON/OFF command of individual pumps. However Bidder shall provide local prewired control panel complete with i) Start/stop push buttons ii) Indicating lamps iii) Local/Remote selection iv) Stroke position indicator v) Rise/Lower push buttons for stroke position vi) Local LED based annunciation driven by BOP C&I part of DDCMIS (under Employer's scope) vii) Stroke position indicator on the panel.

(j.) The normal mode of operation of dosing system shall be through BOP C&I part of DDCMIS (under Employer's scope). Local/Remote selection is to be done from Remote (CR) and indication for the same is to be provided on local panel.

(k.) The ON/OFF commands for individual pumps from local push buttons shall act on the respective drives through BOP C&I part of DDCMIS (under Employer's scope).

16.01.00 The stroke position and adjustment will be done by 4-20 mA D.C. signal from BOP C&I part of DDCMIS (under Employer's scope) and the pumps stroke actuation should be suitable for accepting 4-20 mA D.C. signal. The pumps are to be provided with 24 V DC, two wire LVDT type position feed back transmitter which will generate 4-20 mA signal indicating stroke position

17.00.00 SPECIFICATION FOR SURFACE PREPARATION & PAINTING

17.01.00 Surface preparation methods and paint/primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified, specific approval shall be obtained by the contractor in writing from the employer for using the substitute material.

17.02.00 All paints shall be delivered to job site in manufacturers sealed containers. Each container shall be labeled by the manufacturer with the manuacturer's name, type of paint, batch number and colour.

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CLAUSE NO.	TECHNICAL REQUIREMENTS
17.03.00	Unless specified otherwise, paint shall not be applied to surfaces of insulation, surfaces of stainless steel/nickel/ copper/brass/ monel/ aluminum/ hastelloy/lead/ galvanized steel items, valve stem, pump rods, shafts, gauges, bearing and contact surfaces, lined or clad surfaces.
17.04.00	All pipelines shall be Colour coded for identification as per the NTPC Colour-coding scheme, which will be furnished to the contractor during detailed engineering..
17.05.00	**SURFACE PREPARATION**
17.05.01	All surfaces to be painted shall be thoroughly cleaned of oil, grease and other foreign matter. Surfaces shall be free of moisture and contamination from chemicals and solvents.
17.05.02	The following surface schemes are envisaged here. Depending upon requirement any one or a combination of these schemes may be used for surface preparation before application of primer. SP1 Solvent cleaning SP2 Application of rust converter (Ruskil or equivalent grade) SP3 Power tool cleaning SP4 Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer) SP4* Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns SP5 Phosphating SP6 Emery sheet cleaning/Manual wire brush cleaning.
17.06.00	**APPLICATION OF PRIMER/PAINT**
17.06.01	The paint/primer manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.
17.06.02	Surfaces prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surfaces.

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC
17.06.03	Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.	
17.06.04	Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.	
17.06.05	Following are the Primer/painting schemes envisaged herein: PS3 - Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104. PS3* - Zinc Chrome primer (Alkyd base) by dip coat. PS4 - Synthetic Enamel (long oil alkyd) to IS2932. PS5 - Red oxide zinc phosphate to IS-12744. PS9 - Aluminum paint to IS 2339. PS9* - Heat resistant Aluminum paint to IS-13183 Gr.-I (for temperature above 400 °C) and to IS-13183 Gr.-II (for temperature 200 °C - 400 °C) PS13 - Rust preventive fluid by spray, dip or brush. PS14 - Weldable primer-Deoxaluminate or equivalent. PS16 - High Build Epoxy CDC mastic `15'. PS17 - Aliphatic Acrylic Polyurethane CDE134 ,%V=40.0(min.) PS18 - Epoxy based TiO2 pigmented coat PS19 - Epoxy based Zinc phosphate primer (92% zinc in dry film (min.), %VS=35.0(min.). PS20 - Epoxy based finish paint.	

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CLAUSE NO.	TECHNICAL REQUIREMENTS
17.06.06	All weld edge preparation for site welding shall be applied with one coat of weldable primer.
17.06.07	For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

DRAWING DOCUMENT DISTRIBUTION SCHEDULE

CLAUSE NO.	PART OF TECH. SPECIFICATION NO. PE-TS-401-168-A001

S.NO	DESCRIPTION OF DOCUMENTS		NO OF PRINTS	NO. OF CD-ROMs
1.	PLANT DEFINITION MANUAL		2 Sets	4 CD-ROMs
2.	Drawings "FOR APPROVAL"			
	i) Layout drawings / P&IDs		6	2 CD – ROMs
	ii) Other drawings		2	2 CD - ROMs
3.	Drawings "FOR INFORMATION"		2	2 CD – ROMs
4.	Drawings "FINAL DRAWING"		15	4 CD-ROMs
5.	Drawings "AS BUILT "		15	4 CD-ROMs
6	DATASHEETS, DESIGN CALCULATIONS, PURCHASE SPECIFICATIONS, etc. and Other type of documents			
	(i)	For Approval	2	2 CD – ROMs
	(ii)	FINAL	15	4 CD-ROMs
	(iii)	Analysis reports of equipments/ piping/ structures components/ systems employing software packages as detailed in the specifications	2	2 CD - ROMs
7.	Erection manual "1st Submission"		4 Sets	2 CD – ROMs
8	Erection manual "FINAL"		4 Sets	4 CD ROMs
9	Operation & Maintenance manual "1st submission"		4 Sets	2 CD - ROMs
10	Operation & Maintenance manual "FINAL"		4 Sets	4 CD-ROMs
11	Plant Hand Book "1st Submission"		4 Sets	2 CD ROMs
12	Plant Hand Book "FINAL"		4 Sets	4 CD ROMs
13	Commissioning and Performance Procedure manual "1st Submission"		4 Sets	2 CD-ROMs
14	Commissioning and Performance Procedure manual "FINAL"		4 Sets	4 CD ROMs

CLAUSE NO.	PART OF TECH. SPECIFICATION NO. PE-TS-401-168-A001

S.NO	DESCRIPTION OF DOCUMENTS		NO OF PRINTS	NO. OF CD-ROMs
15	Performance and Functional GURANTEES TEST REPORT		4 Sets	4 CD ROMs
16	Project completion report		15	4 CD ROMs
17	QA programme including Organisation for implementation and QA system manual (with revision-servicing)		1	1 CD ROM
18	Vendor details in respect of proposed vendors including contractor's evaluation report.		1	1 CD ROM
19	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, PQR etc.			
	(i)	For review/comment	2	2 CD-ROMs
	(ii)	For final approval	2	2 CD ROMs
20	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals			
	1st Submission		4 Sets	2 CD ROMs
	Final		4 Sets	4 CD ROMs
21	QA Documentation Package for items / equipment manufactured and despatched to site		2 Sets	4 CD ROMs
22	QA Documentation Package for field activities on equipment / systems at site		2 Sets	4 CD ROMS

LIST OF DOCUMENT TO BE SUBMITTED

SL. NO.	BHEL DRG NO	DRG TITLE	Document submission schedule	Document Size
1	PE-V7-401-168-A001	P&I DIAGRAM FOR H2 GENERATION PLANT WITH I/O LIST	4	A1
2	PE-V7-401-168-A002	EQUPMENT LAYOUT OF H2 GENERATION PLANT	4	A1
3	PE-V7-401-168-A003	SUB VENDOR LIST HYDROGEN GENERATION PLANT	4	A4
4	PE-V7-401-168-A004	EQUIPMENT FOUNDATION AND FLOOR DRAIN DETAILS OF H2 GENERATION PLANT	6	A1
5	PE-V7-401-168-A005	DESIGN & CONTROL PHILOSOPHY OF H2 PLANT ALONG WITH INTERLOCK AND LOGIC DIAGRAM	6	A4
6	PE-V7-401-168-A006	DATA SHEET, GA & CIRCUIT DIAGRAM OF RECTIFIER TRANSFORMER	6	A4
7	PE-V7-401-168-A007	QAP FOR RECTIFIER	6	A4
8	PE-V7-401-168-A008	GA OF H2 AND N2 GAS MANIFOLD, CYLINDERS AND CYLINDER TESTING APPARATUS	6	A4
9	PE-V7-401-168-A009	GA OF FEED WATER, KOH TANK AND GAS HOLDER	6	A4
10	PE-V7-401-168-A010	QAP FOR FEED WATER, KOH TANK AND GAS HOLDER		A4
11	PE-V7-401-168-A011	GA OF ELECTROLYSER AND PURIFICATION SKID	6	A4
12	PE-V7-401-168-A012	QAP FOR ELECTROLYSER AND PURIFICATION SKID	6	A4
13	PE-V7-401-168-A013	ELECTRICAL LOAD DATA	8	A4
16	PE-V7-401-168-A016	DATA SHEET AND GA FOR COMPRESSORS WITH MOTOR	10	A4
17	PE-V7-401-168-A017	QAP FOR COMPRESSOR WITH MOTOR	10	A4
18	PE-V7-401-168-A018	DATA SHEETS FOR INSTRUMENTS	10	A4
19	PE-V7-401-168-A019	DATA SHEET FOR ANALYSERS	10	A4
20	PE-V7-401-168-A020	DATA SHEET OF VALVE	10	A4
21	PE-V7-401-168-A021	QAP FOR VALVES	10	A4
22	PE-V7-401-168-A022	PIPING LAYOUT FOR HYDROGEN GEN PLANT	10	A1
23	PE-V7-401-168-A023	QAP FOR HYDROGEN GEN PLANT (BALANCE OF ITEMS)	10	A4
24	PE-V7-401-168-A024	DATA SHEETS FOR PUMPS WITH MOTOR	12	A4
25	PE-V7-401-168-A025	QAP FOR PUMPS WITH MOTOR	12	A4
26	PE-V7-401-168-A026	DATA SHEET, GA AND WIRING DETAILS FOR PLC PANEL, BOM, PLC CONFIGURATION DIAGRAM	12	A4
27	PE-V7-401-168-A027	QAP FOR PLC	12	A4
28	PE-V7-401-168-A028	CABLE TRENCH / TRAY LAYOUT FOR HYDROGEN GENERATION PLANT WITH DETAILS OF CABLE TRAYS AND ACCESSORIES	12	A1

29	PE-V7-401-168-A029	Lighting Design/ Layout for Hydrogen Generation Plant	12	A1
30	PE-V7-401-168-A030	DATA SHEET, GA AND WIRING DIAGRAM OF BATTERY CHARGER/UPS	12	A4
31	PE-V7-401-168-A031	ERECTION PROCEDURE	16	A4
32	PE-V7-401-168-A032	CABLE SCHEDULE	16	A4
33	PE-V7-401-168-A033	ENGINEERING BOQ	20	A4
34	PE-V7-401-168-A034	Demonstration Procedure for Hydrogen generation Plant	20	A4
35	PE-V7-401-168-A035	O&M MANUAL OF H2 GEN PLANT	24	A4

Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end

- Internet explorer version – Minimum Internet Explorer 7
- Internet speed – 2 mbps (Minimum preferred)

1. Pop ups from our external DMS IP (124.124.36.198) should not be blocked

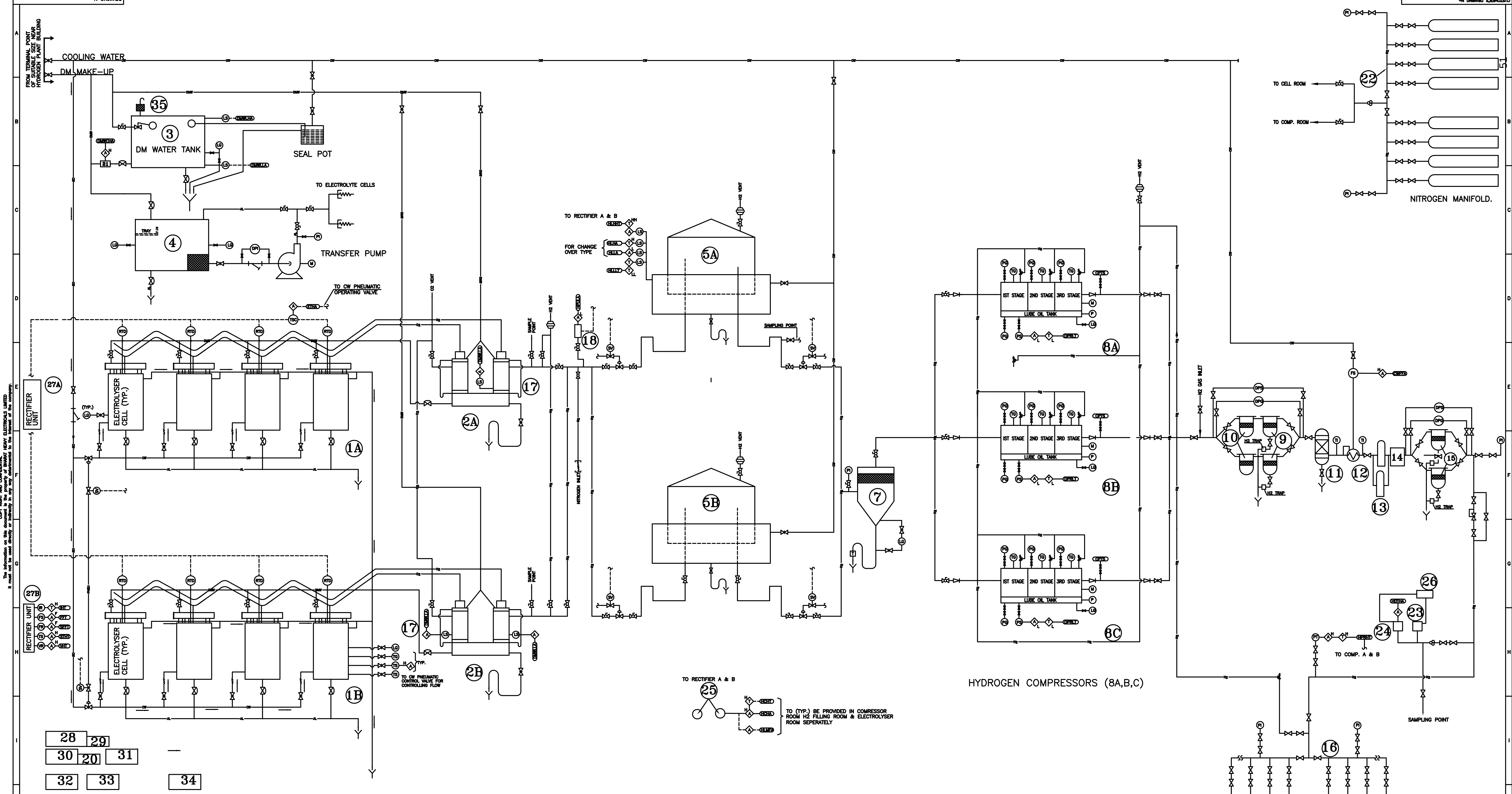
- Vendor's Internal proxy setting should not block DMS application's link (http://124.124.36.198/wrenchwebaccess/login.aspx)"
- DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
- For quick access bidder may refer the link http://bhelpem.com/DMSManuals/DMSManuals.html

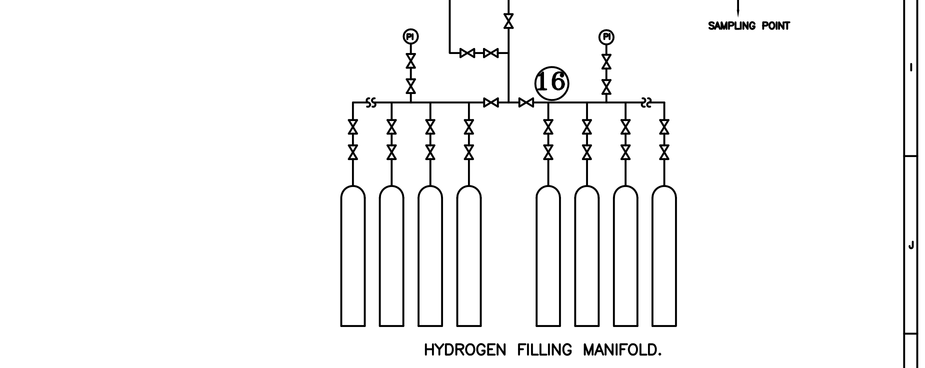
Note:- Bidder to note that the BBU of Hydrogen Generation Plant shall be detailed one and shall be equal to BOQ

P&I DIAGRAM

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM





NOTES

1. THIS P&ID IS TYPICAL FOR UNIPOLAR SYSTEM. P&ID CAN BE DIFFRENT FOR BIPOLAR SYSTEM.
2. ANY OTHER INSTRUMENT & DEVICES REQUIRED FOR EFFICENT & SAFE OPERATION OF PLANT SHALL BE SUPPLIED.
3. NO. OF STAGES IN COMPRESSOR SHALL BE AS PER INLET/OUTLET PRESSURE REQUIREMENT AS PER MANUFACTURERS PRACTICE /PROCESS.
4. GAS HOLDERS ARE APPLICABLE FOR UNIPOLAR ONLY.
5. RELATIVE SEQUENCE OF GAS HOLDERS,PURIFIERS,COMPRESSORS TO SUIT MANUFACTURERS PROCESS DESIGN.
6. NO. OF ELECTROLYSER CELLS/MODULES PER STREAM TO SUIT MANUFACTURERS PROCESS DESIGN.
7. REQUIREMENT OF GAS WASHING TANK/MIST ELIMINATES/KNOCK OUT DRUMS ETC. SHALL BE AS PER MANUFACTURERS DESIGN.
8. IN CASE OF BIPOLAR DESIGN, GAS PURIFYING SYSTEM MAY BE PART OF ELECTROLYSRER MODULE. AS PER MANUFACTURERS DESIGN.

LEGEND & MINOR INSTRUMENT LIST

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
		DMWLLA	DM WATER LOW LEVEL ALARM-II GAS WASHING TANK/DM WATER TANK	HPRLA	H2 PRESSURE LOW ALARM
		OPRLT	LUBE OIL PRESSURE TRIP-COMPRESSOR	CPTS	COMMON PRESSURE PUMP SWITCH-COMPRESSOR
	CONDENSATE TRAP	CWFFA	COOLING WATER FLOW FAILURE ALARM	DMWLHA	DM WATER LEVEL HIGH ALARM
	PUMP	HSFHA	H2 SUCTION FILTER DIFFERENTIAL HIGH ALARM	HPULA	H2 PURITY LOW ALARM-TRACE O2 ANLYSER
	MOTOR	TSC	TEMPERATURE SCANNER	HCHA	H2 CONCENTRATION HIGH ALARM
	DRAIN	SFFT	THYRISTOR FUSE FAIL TRIP (RECTIFIER)	ETHA	ELCTROLYSE TEMP. HIGH ALARM
	FLAME ARRESTOR	STHT	RECTIFIER SINK TEMP HIGH TRIP (RECTIFIER)	HLLA	H2 LEVEL LOW ALARM
	STRAINER	VHT	DC OVER VOLTAGE TRIP (RECTIFIER)	DMWCHA	DM WATER CONDUCTIVITY HIGH ALARM
	SOLINOID VALVE	IHT	DC OVER CURENT TRIP (RECTIFIER)	HTHA	H2 TEMP HIGH ALARM
	BACK PRESSURE VALVE	FS	FLOW SWITCH	HPRHT	H2 PRESSURE HIGH TRIP COMPRESSOR
	SAFETY VALVE	DPI	DIFFERENT PRESSURE INDICATOR	LS	LEVEL SWITCH/LIMIT SWICTH
	FLOAT VALVE	DPS	DIFFERENT PRESSURE SWITCH	LG	LEVEL GAUGE
	PNEUMATIC OPERATED VALVE	FFT	COOLING FAN FAIL TRIP (RECTIFIER)	TIS	TEMP INDICATOR SWITCH
	NON-RETURN VALVE	RTD	RESISTANCE TEMP DETECTOR	HLLLT	H2 LEVEL LOW LOW TRIP (COMPR.)
	NEEDLE VALVE	HLMFA	H2 LEAKAGE MONITOR FAULT ALARM	HLHHT	H2 LEVEL HIGH HIGH TRIP (RECTIFIER)
	DIAPHRAGM VALVE	PRS	PRESSURE REDUCING STATION	PS	PRESSURE SWITCH
	BALL VALVE	HCHT	H2 CONCENTRATION HIGH TRIP	PI	PRESSURE INDICATOR
	GLOBE VALVE	HDTHA	H2 DEW POINT TEMP HIGH ALARM	HLHA	H2 LEVEL HIGH ALARM
	GATE VALVE		ADJUSTABLE THROTTLE	TI	TEMP INDICATOR

EQUIPMENT & INSTRUMENT LIST

S.NO.	DESCRIPTION	QTY.	S.NO.		QTY.
19	SUCTION FILTER	2			
18	% OXYGEN /TRACE O2 ANALYSER (L.P. SIDE)	1			
17	MANOMETER	8			
16	HYD. GAS MANIFOLD (2X4 CYL.)	1SET			
15	DUST FILTER	2	35	CO2 ABSORBER	1
14	DRIER (DUAL TOWER)	1	34	MCC	1
13	COALESCING FILTER	2	33	ORSAT ANALYSER	1
12	AFTER COOLER CUM SEPERATOR	1	32	PORTABLE SPECIFIC GRAVITY MEASURING INSTRUMENT	2
11	DE- OXY PURIFIER	1	31	PORTABLE TRACE OXYGEN ANALYSER	1
10	OIL ABSORBER FILTER	2	30	H2 CYL. TESTING APPARTUS	1
9	PRE FILTER	2	29	ISI/ZENER BARRIER PANEL	1
8A,B,C	HYD. COMP. WITH NON SPARKING TYPE MOTORS	3	28	CONTROL PANEL	1
7	KNOCK OUT DRUM FOR HYD.	2	27A,B	RECTIFIER UNIT	2
		2	26	MULTI PEN RECORDER	1
		2	25	H2 LEAK DETECTION SYSTEM	LOT
5A,B	GAS HOLDER FOR HYD.	2	24	MOISTURE ANALYSER (DEW POINT METER)	1
4	ELECTROLYTE PREP. TANK & TRANSFER PUMP	1	23	TRACE OXYGEN ANALYSER (H.P. SIDE)	1
3	D.M .WATER TANK	1	22	N2 PURGING SYSTEM (2X4 CTL.)	1SET
2A,B	GAS WASHING TANK	2	21	D.M. WATER CONDUCTIVITY METER	1
1A,B	ELECTROLYSER CELLS	AS REQD.	20	VACUUM PUMP	1

SYMBOL	LEGEND
AL	ALKALI LINE
O2	OXYGEN LINE
- - - - -	ELECTRICAL LINE
CW	COOLING WATER LINE
N2	NITROGEN LINE
H2	HYDROGEN LINE

JOB No. : 401	OWNER: NATIONAL THERMAL POWER CORPORATION
STATUS: CONTRACT	PROJECT: 1X500 MW, UNCHAHAR TPP
DISTRIBUTION	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI
REV / DATE / ALTD / CHD / APPD	DEPT CODE: M — DRN: FS; DESN: FS; CHD: FS; APPD: SB
TITLE	P&I DIAGRAM FOR HYDROGEN GENERATION PLANT
DEPT. / SCALE / SIGN / DATE	DRAWING No. PE-DG-404-168-A001
SHEET OF	REV-0

SIZE-A2

CUSTOMER'S DRAWING No.

DRAWING No.

MANDATORY SPARES

S.No.	Mandatory Spare	Total QTY
1.0	Transmitters of all types and model no. (for the measurement of Pressure, differential pressure , temperature, flow, level, etc.)	10% or 1 No. of each type, ranges and model whichever is more.
2.0	**24 V DC power supply system**	
a.	Electronic modules of all types.	10% or 2 Nos. of each type and model, whichever is more.
b.	Silicon controlled thyristors, diodes, power transistors,	100%
	Capacitors	1 Set.
	Fuse free Circuit breakers	5% or 1 Nos. of each type, and rating, whichever is more
	Cooling Fans	10% or 2 nos. of each type whichever is more.
3.0	RTD's of each type and length.	10% or 2 Nos. whichever is more.
4.0	Thermocouples of each type like K-type, R-type, metal etc. and length.	10% or 2 Nos. whichever is more.

GUARANTEED POWER CONSUMPTION

SL. NO.	MAJOR EQUIPMENTS NAME	TOTAL POWER CONSUMPTION (IN KW) TO OPERATE ONE STREAM (AT RATED CAPACITY) OF HYDROGEN GENERATION PLANT
1	ELECTROLYSER	
2	COMPRESSOR	

INFORMATION TO BE FURNISHED BY THE BIDDER ALONG WITH BID

DOCUMENTS TO BE FURNISHED ALONG WITH THE OFFER (4 SETS):-

1. Bidder to specify the deviations from the specification. If any, in the schedule of deviations enclosed as Volume-III, of technical specification. In the absence of duly filled in schedule, it will be presumed that the offer confirms to the specifications in all respects.
2. Electrical load data duly filled in. The format for electrical load is enclosed as annexure – 5, section C2 of technical specification.
3. Guaranteed power consumption duly filled in. The format for guaranteed power consumption is enclosed in section C1 of technical specification.
4. Bidder shall clearly bring out in the proposal the redundancy features along with configuration diagram and this shall be subjected to BHEL / Employer's approval during detailed engineering.
5. List of spares for:
    - Commissioning spares
    - Recommended spares

6. Any other details mentioned elsewhere.

SECTION – C2

SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)

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

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Erection and Commissioning spares.

c) Erection & Maintenance tools & tackles.

d) Electrical load requirement for Hydrogen generation plant.

e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

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

Refer "Electrical Scope between Customer and Vendor".

3.0 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 "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.

ANNEXURE -4 ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: HYDROGEN GENERATION PLANT

PROJECT: 1X500MW UNCHAHAR TPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Customer	Customer	1. 415 V AC/240 V AC supply shall be provided by Customer 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 Customer in MCCs. Requirement of these relays shall be furnished by vendor during detailed engineering stage.
2	Local Push Button Station (for motors)	Customer	Customer	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in Customer's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 Customer Customer Customer	 Customer Vendor Customer	1. Sizes and quantity of cables required shall be informed by vendor at contract stage (based on inputs provided by Customer). Finalisation of cable sizes shall be done by Customer. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by Customer except for cabling in vendor scope. 3. Termination at Customer equipment terminals by Customer. 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	Within the Battery Limits
5	Cable trays, accessories & cable trays supporting system	Customer	Customer	
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 approval at contract stage.

ANNEXURE -4 ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: HYDROGEN GENERATION PLANT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
8	Lighting	Customer	Customer	
9	Equipment grounding & lightning protection	Customer	Customer	
10	Below grade grounding	Customer	Customer	
11	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer approval at contract stage.
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 Customer 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 Customer 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 customer after award of contract.
2. All QPs shall be subject to approval of customer after award of contract without any commercial implication.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

ANNEXURE-5

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	401	ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	1X500 MW FGUTPP STAGE-IV	NAME		DATA FILLED UP ON
		SYSTEM / S	HYDROGEN GENERATION SYSTEM	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION		SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

SECTION – D1

DESIGN REQUIREMENTS
MECHANICAL

NOTE: - Some of the design requirement specified in section D1 may not be applicable to the bidder design. These requirements shall be accepted as per manufacturer standard practice.

CLAUSE NO.	TECHNICAL REQUIREMENTS

HYDROGEN GENERATION PLANT

1.00.00 GENERAL PLANT DESIGN CRITERIA

(a.) To be designed for continuous, as well for as two shift or one shift operation.

(b.) The scheme shall be based on manufacturer's standard. Hydrogen generation plant offered can either be of uni polar design or bipolar design as per manufacturer's standard practice.

(c) Total Plant Capacity to be sized as follows:

Leakage rate per generator = "A" NM^3/day

Requirement of one generator filling = "B" NM^3.

Number of Units = C

Hydrogen generation plant Capacity = [C*1.5* A + B/30]/12 NM^3/hr

d) The Plant capacity would be based on the Criteria detailed out above. However, total plant capacity in no case shall not be less than 10 NM3/hr with two streams of 50% Capacity each of minimum 5 NM3/hr.

e) Hydrogen purity to be maintained at gas manifolds 99.9%

f) Moisture content in hydrogen: - 0.05 gm/m3 (max.)

g) 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.

h) Hydrogen cylinder testing facility, if required by statutory authorities, also needs to be provided by the bidder.

i) Description of various components of Hydrogen generation plant has been discussed below. Some of the components specified here in 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.

CLAUSE NO.	TECHNICAL REQUIREMENTS
2.00.00	**GENERAL OPERATIONAL CRITERIA/PHILOSOPHY**
	(a.) To be designed for Continuous duty.
	(b.) To be designed for parallel operation of both streams.
	(c.) Flexibility to operate electrolyser in part load.
	(d.) Complete operation from remote control panel/OWS.
	(e.) To trip the plant in case of high hydrogen level inside the building suitable numbers of hydrogen gas detectors to be provided by the bidder for each of the room.
	(f.) Set pressure to be maintained with help of back pressure regulation valve.
	(g.) Automatic operation of standby compressor as and when required.
	(h.) To provide alarm & tripping of compressor based on suction conditions.
3.00.00	**CONSTRUCTION DETAILS OF EQUIPMENT**
3.01.00	**Electrolysers/ Generator (as applicable)**
	(a.) Cells in electrolysers/ generator shall be connected to each other. Further for Uni polar design, there shall be provision to isolate any one of them Cells in electrolysers. The Cells in electrolysers / generator shall be of corrosion resistant material.
	(b.) The electrolysers/ generator to be designed to operate at part load of normal capacity without any disconnection and operation interruption and shall produce the hydrogen gas of specified purity and dryness.
	(c.) All measuring instruments, controllers and control valves shall be provided.
	(d.) Safety devices are to be provided on each collecting pipe to release gas pressure in case it goes above the limits.
	(e.) To be designed so that it can be dismantled, cleaned, and reassembled easily.
	(f.) Proper sealing shall be provided by the Bidder while crossing the wall to avoid any gas leakage to Rectifier Room.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(g.) Each electrolysers/ generator shall be fitted with the following instrumentation. (1.) In uni polar design one explosion proof temperature switch in each cell for electrolysers' temperature high alarm on the control panel. In case of bipolar design one explosion proof temperature switch in each generator module for electrolyser's temperature high alarm on the control panel. (2.) A local pneumatic temperature controller, controlled through PLC, to maintain the electrolysers temperature to a preset value by controlling cooling water flow to the electrolyser through the temperature control valve. (3.) One temperature gauge for local indication for electrolyte temperature. (4.) One off-line specific gravity measuring instrument.
3.02.00	**Rectifier (if applicable)** Two nos, of rectifier (one for each electrolyser) to cater to the load of each of the electrolyser. The rectifier equipment shall be complete in all respects with air-cooled rectifier transformer, thyristor converter, electronic control and annunciation, fillers choke etc mounted in suitable panels.
3.03.00	**Gas washing Tanks (if applicable)** One for each electrolyser with manometers at inlet and outlet, temperature gauge, level switches for controlling the level of DM water in the tank etc.
3.04.00	**Demineralised water tank** (a.) One number tank of Capacity adequate for 5 days normal requirement of hydrogen gas generation on continuous basis at rated capacity of 10 NM3/hr. (b.) To be fitted with removable drain connections, level switches/ transmitter, level indicators etc.
3.05.00	**Caustic solution mixing tank (if applicable)** (i) Capacity - Suitable to fill one electrolyser

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(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 (for unipolar design)** (i) Number — Two (2) numbers (one for filling, one for supply to compressor) (ii) Capacity of each gas holder — Minimum of 5 M^3. (iii) Material — IS-2062/2002 or equivalent (iv) To be designed for outdoor duty (v) To provided with two (2) Seal pots for each gas 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 trough flame arrestor.
3.07.00	**De-oxy unit (if applicable)** Numbers — 1 (To handle both the streams and capable to remove oxygen as impurity) Accessories — 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)

CLAUSE NO.	TECHNICAL REQUIREMENTS	
	(ii) Capacity of each compressor	125% of each stream
	(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	Constant speed Sq. cage flame proof type Electric motor suitable for group-II-C location as per IS:2148 Clause-I Div.-I of NEC.
	(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.	
	(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.	
	(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.	

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CLAUSE NO.	TECHNICAL REQUIREMENTS
3.09.00	**Drying system for Hydrogen gas(if applicable)**
	(a.) To provide twin tower Moisture separating columns of Regenerative design alongwith instruments.
	(b.) 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**
	(a.) Spring loaded disc operated self actuating type back pressure regulating valve to maintain 150 kg/cm2 (g) pressure on the compressor discharge.
	(b.) To be provided with accessories such as Pressure sensing element, controller etc.
3.11.00	**Cylinder Manifold**
	(a.) To provide one dual cylinder filling manifold, arranged for two banks of minimum four cylinders each.
	(b.) To provide accessories such as Isolating valves, safety valves, Pressure gauges, pressure switch (To shut-off compressors beyond set pressure) "ON-LINE" Hydrogen purity analyser, trace oxygen analyser, moisture analyser at cylinder manifold, records of hydrogen purity and moisture content, & one number PORTABLE hydrogen gas purity testing kit.
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	**Hydrogen leak detection system:**
3.13.01	Hydrogen leak detection and interlock system shall be provided in generator/ compressor rooms and hydrogen filling area for alarm and trip of Hydrogen generation plant.
3.14.00	**Air Compressors (If required)**
	In case bidder's Hydrogen generation plant requires compressed air, 2X100% capacity air compressors need to be provided by the bidder. If Instrument quality

CLAUSE NO.	TECHNICAL REQUIREMENTS
	compressed air is required, in such case 2X100% capacity air drying plant also needs to be provided.
3.14.00	**Piping**
	(a.) All Pipe to conform to ASA pressure piping code, and seam less type.
	(b.) All high pressure joints shall of ferrule/ welded construction.
	(c.) All vents to be fitted with flame arrestor.
	(d.) All high pressure drains to be terminated through H2 traps and all low pressure drains to be terminated through U-bends.
	(e.) Cooling water pipe be minimum 80 NB size.
4.00.00	**VENTILATION SYSTEM**
	(a.) 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.
	(b.) The air quantity of ventilation system shall be estimated based on minimum 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.
	(c.) Bidder to provide louvers for fresh air supply for the building.
	(d.) 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.

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CLAUSE NO.	TECHNICAL REQUIREMENTS
6.00.00	**CONTROL AND INSTRUMENTATION**
6.01.00	All necessary instruments such as transmitters/temperature elements / sensors / switches / gauges etc. shall be provided by the Contractor for safe, efficient & reliable operation and maintenance of the H2 generation plant. All instrument devices shall be provided with explosion proof enclosure as described in NEC (USA) Article 500, Class-I, Div.-I as specified in relevant Control and Instrumentation Sub-Section of Technical Specification. For further details refer to the requirements specified in control & instrumentation Sub-Section of Technical Specification. The control panel shall be microprocessor/ PLC based.
7.00.00	**PAINTING**
7.01.00	All the Piping, Valves and Equipments of this system shall be protected against external corrosion by providing suitable painting as described elsewhere in the specification.

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

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

(b) **Compressed Air Application**

Compressed air conditions) 6.0 m/sec.(under Average Pressure & Temp.

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 All high points in piping system shall be provided with vents along with valves. All low points shall be provided with drains along with valves. 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	

CLAUSE NO.	TECHNICAL REQUIREMENTS
	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 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.
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).
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

CLAUSE NO.	TECHNICAL REQUIREMENTS
	thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.
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.
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.
2.02.08	For rubber lined ERW pipes, beads shall be removed.
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.
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.
2.02.11	For large size pipes/ducts, at high point and bends/change of direction of flow, air release valves shall be provided. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code. Transient analysis /surge analysis 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.
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.

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CLAUSE NO.	TECHNICAL REQUIREMENTS	
2.03.05	Material of construction for pipes carrying various fluids shall be as follows:	
	1 Raw water, ash water, circulating Water, aux. cooling water, clarified Water, service water, air pre-heater Wash water, clarifier sludge and Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW drain water	IS-2062Gr.B/ASTMA36/ASTM A-53 type 'E' Gr.B / IS-3589 Gr. 410 /IS-1239 Heavy. For equipment cooling water system wherever DM water is used or alkaline solution is used for pipes 50NB and below, pipe material shall be stainless steel to ASTM A312 Gr. 304 sch. 40 Seamless.
	2 Demineralised water, (condenser Make up water, Boiler fill and Deaerator Fill water, equipment cooling Water piping from overhead tank to Suction header of DMCW and chemical dosing system to Primary circuit of equipment Cooling water (DMCW System), ECW overhead tank make-up water	Stainless steel to ASTM A-312, Gr.304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50mm and below
	3 Drinking water galvanized/ IS 1239 heavy	ASTM A-53 type E Gr. B galvanized/IS 3589 Gr 410 Galvanized to IS- 4736 or equivalent.
	4. Instrument air & plant air. galvanized/ IS 1239 heavy galvanized to IS- 4736 or	ASTM A-53 type E Gr. B galvanized/IS 3589 Gr 410 equivalent.
	5. (Condensate) spill water/ Deaerator Drain	ASTM A 106 Gr. B
	6. Oil piping	API 5L
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. 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).	

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CLAUSE NO.	TECHNICAL REQUIREMENTS
2.03.08	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. 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.
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

CLAUSE NO.	TECHNICAL REQUIREMENTS
	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 and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.
2.05.00	**Slope/Drains and Vents**
2.05.01	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. In addition to the system requirement all low points in the pipelines shall be provided with suitable draining arrangement and all 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.
2.05.02	Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.
2.06.00	**Pipe Joints**
	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.

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

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	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.
2.06.03	**Flanged**
	(a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.
	(b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.
	(c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.
2.07.00	**Bends/elbows/mitre bends/ Tees/ Reducers & other fittings**
2.07.01	Unless otherwise specified elbows shall be of long radius type.
2.07.02	For pipe sizes up to 65Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.
2.07.03	For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. 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.
2.07.04	Mitre bends are not acceptable in case of rubber lined mild steel pipes.
2.07.05	For pipe fittings such as reducers and tees, the material shall be to astm-a-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fitting shall conform to the dimensional standard of ANSI B-16.9. 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.

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	For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
2.07.06	Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any) Class-S, for sizes up to and including 50mm NB, i.e., the fitting shall be of seamless construction. However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.
2.07.07	In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.
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*

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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. (b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager. (c) 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. (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.
2.09.03	**Coating and wrapping** (a) Buried piping shall be coated and wrapped, as per specification, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are: (1) Coating primer (coal tar primer) (2) Coating enamel (coal tar enamel) (3) Wrapping materials. (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. (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 (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. (e) Total thickness of completed coating shall not be less than 4.0 mm.

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	(f) Alternatively, the anti-corrosive protection can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to AWWA-C-203. These-tapes shall be applied hot over the cold coal 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.
2.09.04	**Trench bed preparation and back filling** Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.
2.09.05	**Laying of galvanized steel (GI) pipes** All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joint shall be applied with Zinc silicate paste. All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and " anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.
2.10.00	**Cleaning and flushing**
2.10.01	All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.
2.10.02	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.
2.10.03	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.
2.10.04	All compressed air pipe work shall be cleaned by blowing compressed air.
2.11.00	**Surface preparation and painting** 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 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.**

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2.11.01	**Primer painting** (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. (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.
2.11.02	**Finish painting** (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. (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. (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. (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. (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. (f) The dry film thickness (DFT) after the painting shall not be less than 150 microns.
2.11.03	**Other requirements** (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc. (b) The color of the finish paint shall be as per approved color-coding. (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site. (d) The dry film thickness of paint shall not be less than 0.15 mm.

2.11.04	Color code for identification The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.
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 with in 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 & 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.
2.13.00	**Design/Construction/Material Particulars of Gate/ Globe/Check Valves/ Globe Stop Valve/Butterfly valve**
2.13.01	GENERAL (a) All valves shall be suitable for the service conditions i.e flow, temperature and pressure, at which they are required to operate.

(b) 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:

(1) The internal parts shall be suitable to support the pressure caused by the actuators;

(2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.

(3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.

(4) All actuators operated valves shall open/ close fully within time required by the process.

(j) Valves coming under the purview of IBR shall meet IBR requirements.

(k) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:

(1) Hand wheel

(2) Position indicator (for above 50 mm NB valve size)

(3) Bypass valves and gear operators for valves of size 350 NB & above.

(3) Draining arrangement wherever required.

(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.

(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

(n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

(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) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(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. 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.

(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.

(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.

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2.13.02	**VALVE BODY MATERIAL** Valve body material for various services shall be as follows: Valve body material for water application like circulating water, Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65NB and above; gun-metal for sizes 50 Nb and below. For compressed air application, valve material shall be galvanized cast carbon steel or galvanized forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below. DM water: SS body and disc along with SS internals. Condensate: Cast Carbon Steel / Forged Carbon Steel.
2.13.03	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. **Standards and Codes** AWWA-C-504 — Rubber seated butterfly valves. BS-5155/EN-593 — Cast iron and carbon steel butterfly valves for general purpose. IS-778 — Gun-metal gate, globe and check valves for general purpose. BS-5154 — Copper alloy globe/globe stop and check and gate valves for general purpose. IS-780 — Sluice valves for water works purpose (50-300 mm size) IS-2906 — Sluice valves for water works purpose (350-1200 mm size) IS-5150 — Cast iron wedge and double disc gate for general purpose. BS-5152 — Specification for cast iron globe valves. BS-5153 — Cast iron check valves for general purpose.

	IS-5312	Swing check type reflux (non-return) valves.
	ANSI B 16.34	Standard for valves.
	API-594	Standard for Dual-check valves.
	API-600	Steel gate valves.
	ANSI-B-16.10	Valves face to face and other relevant dimension.
	API-598	Valves inspection test.

2.13.04 **End Connections**

The end connections, shall comply with the following:

Socket welding (SW) - ANSI B 16.11

Butt Welding (BW) - ANSI B 16.25.

Threaded (SC) - ANSI B 2.1

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

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.

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	(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	**Gate valves** All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate. Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

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2.17.00	**Air Release Valve**
	(a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.
	(b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.
	(c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS: 210 Gr. FG 260. and spindle shall conform to high tensile brass.
	(d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/ butterfly valve.
2.18.00	**Butterfly valves**
2.18.01	**Design/Construction**
	(a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition. Bidder has to clearly indicate the material offered in the bid. No change shall be entertained during detailed engg.
	(1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable
	(2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.
	(3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.

(4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

(5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

(6) The operating mechanism shall be mounted directly on or supported from the valve body.

(7) All valves shall be complete with:

Position indicator (located in a visible place)

Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off"

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

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

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

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

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

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

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures 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
Shaft	ASTM A 182, Gr. 316
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
Disc & Seat Rings	EPT/BUNA-N/Neoprene

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Testing of valves shall be as per AWWA C – 504 or BS – 5155 as applicable. For fabricated body butterfly valves all the longitudinal and circumferential weld seams on valve body shall be 100% radiographed or ultrasound tested.

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
(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
(3)	**Cast iron valves**	
	Body & bonnet	BS 1452 Gr.14/IS-210 Gr.FG 260
	Seating surfaces and rings	13% chromium steel
	Disc for non-return valves	BS 1452 Gr.14/IS-210 Gr FG 260
	Hinge pin for non-return Valves	AISI 316

CLAUSE NO.	TECHNICAL REQUIREMENTS

		Stem for gate globe valves	13% chromium steel
		Back seat	13 % chromium steel
	(4)	**Gun Metal valves**	
		Body and bonnet	IS 318 Gr. 2/ Equivalent Standard
		Trim.	-do-

(b) Cast iron body valves shall have stainless steel stem and seat.

(c) Material for counter flanges shall be the same as for the piping.

2.20.00 **Float operated valves**

(a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) DESIGN AND CONSTRUCTION FEATURES

The following design and construction feature of the valve shall be the minimum acceptable.

(c) Valves shall be right-angled or globe pattern.

(d) Valves shall be balance piston type with float ball.

(e) Leather liner shall not be provided.

(f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or IS: 210 Grade 200 or equivalent, and Float shall be of copper with epoxy painting of two (2) coats.

(g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.

(h) The valves shall have flanged connections.

2.21.00 **PAINTING OF VALVES:**

Two (2) coats of primer followed by three (3) coats of enamel of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of paining shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC
2.22.00	**Tanks and Accessories**
2.22.01	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.
2.22.02	**DESIGN AND CONSTRUCTION** (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. (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. CO_2 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.

2.22.03 **Corrosion protection**

(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.

(d) Epoxy-coating shall be provided on the inside of vessel in three coats (minimum) resulting in total thickness of not less than 150 micron in which ever case required, such as equipment cooling water overhead tank, sodium hydroxide tank, condensate storage tank, condensate surge tank etc.

2.22.04 **Cleaning & Painting**

(a) Inside surface of all tanks shall be protected by anti-corrosive paints as required.

(b) For tanks/vessel requiring epoxy painting, all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

(c) Outside surfaces of all vessels shall be provided with two coats of primer with three (3) coats of epoxy resin based paint of approved color.

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.

CLAUSE NO.	TECHNICAL REQUIREMENTS एनटीपीसी NTPC
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' duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.
2.23.08	The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
2.23.09	All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr B galvanized 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.
2.23.10	The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.
2.23.11	All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.
2.23.12	Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.
2.23.13	Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

CLAUSE NO.	TECHNICAL REQUIREMENTS	NTPC

2.23.14 Bidder to note that any metallic part which comes in contact with DM /corrosive water shall be of Stainless Steel material.

2.24.00 **STRAINERS**

2.24.01 **Simplex type**

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition 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:

(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

2.24.02 **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.

2.24.03 Two shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion.. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited..

TECHNICAL PARTICULARS OF TANKS AND ACCESSORIES

Sl. No.	Description	Tech. Particulars
1.00	CONDENSATE STORAGE TANKS	
1.01	Number required	One per unit
1.02	Capacity of each tank (Effective)	800 Cu.m
1.03	Size (Dia & Height)/Plate Thickness	10.8 x 9.5 m/minimum (shell & roof) plate thickness 8mm and Base plate thickness 10mm
1.04	Type and pressure class atmospheric	Vertical, cylindrical,
1.05	Material of construction	MS- (IS-2062 Gr.B or equivalent) as per specified code, 8mm thickness (minimum)
1.06	Inside protection	Solvent free epoxy coating (minimum two coats) of total DFT 200 microns
1.07	External painting followed by 3 coats of epoxy micron	Epoxy paint (2 coats of primer paint) - minimum DFT 100
1.08	Location	Outdoor
1.09	Overflow, drain, vent and sample connection	Required

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

The term "Performance Guarantees" wherever appears in this Sub-Section-V shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Sub-Section-V shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

The term "BMCR" (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of Steam Generator at superheater outlet at rated parameters.

The term "TMCR" (Turbine maximum continuous rating) appearing in the technical specification shall mean 500 MW electrical power output at generator terminals (power at generator terminals as per clause indicated in this sub-section) under 0% cycle make-up and design condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure.

1.00.00 **PERFORMANCE GUARANTEES**

1.00.01 **General Requirements**

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

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

c) The Contractor shall conduct performance test and demonstrate all the guarantees covered herein, during performance 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.

d) All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation, shall be included in the bid price.

e) i) Bidder shall quote the steam generator efficiency as per the requirements of BS EN 12952-15:2003 (by loss method and based on GCV of Coal) and other specification stipulations.

ii) The guaranteed efficiency quoted by the Bidder shall comply with following limiting parameters with design coal firing:

a)	Excess air at economizer outlet (at 100% TMCR load)	: 20% (min.)
b)	Corrected flue gas temperature at air preheater outlet (at 100% TMCR load)	:125^{O}C or as predicted by the bidder whichever is higher
c)	Loss due to unburnt carbon in ash (at all two guarantee point loads i.e. 80% and 100% TMCR)	: 1.5% (min.)

Bidder/Contractor to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions/ guarantees etc. if the values considered by the bidder/Contractor for parameters indicated at a), b) & c) above are lower than those specified above.

iii) For the purposes of guaranteed efficiency of steam generator the ambient air temperature and relative humidity shall be taken as 27^{O}C and 60% respectively. Further, these guarantees shall be based on design coal firing with coal/ ash analysis as given in Subsection-II (Project Information) of Part-A, Section-VI.

iv) Category-III Guarantees under Cl. No. 1.03.05 of this sub-section for various systems/ equipment for steam generator and auxiliaries shall be based on and demonstrated corresponding to ambient air *condition of 27 deg. C temperature & 60% RH.*

f) In case during performance guarantee tests 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 subsection, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 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:

i) For Category-I Guarantees

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

OR

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 for 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 except for the rate indicated for station auxiliary power consumption which are on station basis. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called `Category - I' Guarantees.

ii) For Category-II Guarantees

Reject the equipment/plant/system 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.

iii) For Category-III Guarantees

Reject the equipment / system/plant & recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the 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 guarantee performance. These parameters/capacities shall be termed as category - III, guarantees.

1.01.00 **GUARANTEES UNDER CATEGORY I**

1.01.01 The performance guarantees which attract liquidated damages are as follows:

i) Turbine Cycle Heat Rate

a) Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at design condenser pressure with zero make up at 500 MW unit load.

1.03.18 **Compressed Air System**

a) Following shall be demonstrated at shop:

i) Capacity and discharge pressure of each air compressor.

b) Following shall be demonstrated at site :

i) Parallel operation of air compressors

ii) Dew point of air at the outlet of air drying plants of instrument air compressor.

iii) Pressure drop across the air drying plants of air compressors.

iv) Vibration and noise level of air compressors, blowers of air drying plant.

1.03.19 **CW Pumps**

Each pump shall be tested at shop/ site (as applicable) for capacity, head and power consumption with the respective job motor. Vibration, noise level and parallel operation shall be demonstrated at site.

1.03.20 **Cooling Towers**

Performance test of Natural Draft Cooling Towers as per the test procedure elaborated elsewhere in the specification for demonstration of guaranteed Cold Water Temperature at design conditions shall be carried out at site. The cold water temperature as specified shall be guaranteed by the bidder for the design condition of CW flow, range, ambient wet bulb temperature specified elsewhere.

1.03.21 **Hydrogen Generation Plant**

i) Power consumption, capacity & discharge pressure of hydrogen gas compressors at its rated duty point with its job (own) motor shall be demonstrated and proved at shop.

ii) Electrolyser & rectifier capacity and power consumption shall be demonstrated at site.

iii) Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of Hydrogen shall be demonstrated at site.

iv) Hydrogen generation plant capacity (stream wise) shall be demonstrated at site.

v) Vibration level and noise level of hydrogen gas compressors shall be demonstrated at site.

1.03.22 **Passenger & Goods Lift of Various Areas**

Over load tests, travel and hoist speed checks, functional & performance tests.

1.03.23 **(i) Performance Guarantee on Vibration Isolation Systems for Machine Foundations**

The contractor shall guarantee the performance of the vibration Isolation System (VIS), to be provided by him for various machine foundations as specified in detailed technical specification, for a period of 24 months from the date of commissioning of each machine.

(ii) Performance Guarantee on Acid / Alkali Resistant Linings & Anti-Weed Treatment

The contractor shall furnish a performance guarantee for the acid/ alkali resistant linings and anti-weed treatment, as specified in detailed technical specification, for a period of three years from the date of completion of work or date of handing over, whichever is later.

(iii) Any defect observed during the guarantee period shall be made good by the contractor by re-carrying out/ replacing or by rectifying (if the defect is localised) the acid-alkali resistant linings and the anti-weed treatment, to the entire satisfaction of the Employer without any extra cost to the Employer.

1.03.24 For all other equipment included in the scope of supply of the bidder but not covered above, the demonstration tests to be carried out shall be mutually finalised between contractor & Employer after award of contract.

1.03.25 **Control & Instrumentation System Requirements**

(DDCMIS SYSTEM GUARANTEE REQUIREMENTS)

1.03.25.01 The parameters/capabilities to be demonstrated for various systems/ equipments shall include but not be limited to the following:

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

5.0 FITTINGS

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

a. Neck collar
b. Protection cap
c. Outlet valve to IS:3224
d. Safety valve/Bursting disc.

6.0 CAPACITY

a.	Water capacity	-	46.7 liters
b.	Volume gas	-	7m³(app.)

7.0 WORKING PRESSURE - 150kg/cm²

8.0 MATERIAL

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

9.0 REQUIREMENT OF CYLINDERS

As per IS:7285

10.0 PAINTING & MARKING ON CYLINDERS

To be as per IS : 7285

11.0 INFORMATION REQUIRED WITH THE OFFER

Cylinder drawing indicating the following details:

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 strech test pressure.

12.0 TEST CERTIFICATES

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

13.0 GENERAL

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

SECTION – D2

DESIGN REQUIREMENTS
ELECTRICAL

NOTE: - Some of the design requirement specified in section D2 may not be applicable to the bidder design. These requirements shall be accepted as per manufacturer standard practice.

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement ofr rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechnical vibration of rotatinf electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information

Motors ahall be continuously rated (S1). Motor ratings shall have at least a 10% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified in Data Sheet-A.

Type of motors shall be as per below

AC motors:

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

b) **Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be Energy Efficient motors, Efficiency class-Eff 1,conforming to IS 12615. Or High efficiency (IE2) as per IEC:60034-30**

DC motors: Shunt wound

3.3 **Starting Requirements**

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

Pull out torque at rated voltage shall not be less than 205% of full load torque.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

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.

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.

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.

Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

3.4 **Running Requirements**

3.4.1 Starting voltage requirement 85% up to 200kW.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechnical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy.

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.

All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. Motors located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below

Hudrogen generation plant : Group-IIC (or Group-I, Div-II as per NEC)

4.2 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.3. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.4 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.5 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

4.6 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

TEMPERATURE RISE

Air cooled motors

70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.

In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance)

(a) Upto 110KW : 11.0

(b) Above 110KW & upto 200 KW : 10.0

Paint shade shall be as per RAL 5012(Blue) for indoor and outdor equipment.

Minimum distance between centre of stud and gland plate shall be as per given below

Sr. no	**Motor MCR in KW**	**Minimum distance between centre of stud and gland plate in mm**
1	Motor MCR in KW UP to 3 KW	As per manufacturer's practice.
2	Above 3 KW - upto 7 KW	85
3	Above 7 KW - upto 13 KW	115
4	Above 13 KW - upto 24 KW	167
5	Above 24 KW - upto 37 KW	196
6	Above 37 KW - upto 55 KW	249
7	Above 55 KW - upto 90 KW	277
8	Above 90 KW - upto 125 KW	331
9	Above 125 KW-upto 200 KW	203

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:

Sr. no	**Motor MCR in KW**	**Clearance**
1	UP to 110 KW	10mm
2	Above 110 KW and upto 150 KW	12.5mm
3	Above 150 KW	19mm

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise statedin Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet “A”.

4.7.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 **INSPECTION AND TESTING**

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the quality plan No. enclosed with this specification and which shall be complied.

5.2 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 *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

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.

5.3 List of tests for which reports have to be submitted

The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

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.

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.

5.3 All aaceptance and routine tests as per the specification and relavent standard shall be carried out at no additional cost to the owner.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 **DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.

ii) Speed vs. time at rated voltage and minimum starting voltage.

iii) Torque vs. speed at rated voltage and minimum voltage.

For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.

iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

	TITLE	SPECIFICATION NO.
	LV MOTORS	VOLUME II B
		SECTION D
	DATA SHEET-A	REV NO. 00 DATE
		SHEET 1 OF 1

1.0	Design ambient temperature	:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor	:	≤200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP54/IP55
5.0	Type of Cooling	:	TEFC/CACA/TETV
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10%
	d) System fault level at rated voltage	:	45 kA for 1 sec
	e) Short time rating for terminal boxes		
	o 110kW & Above (Breaker controlled)	:	45 kA for 1 sec
	o Below 110kW (SFU+ Contactor controlled)	:	45 KA for 0.20 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class ‘F’, with temp rise limited to class B. (Refer clause 5.00.00 of Motors)
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	85% of rated voltage
9.0	Power cables data	:	Shall be given during detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during detailed engg.
11.0	Space heater supply	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
13.0	Tests	:	As per motor spec. (enclosed)
14.0	Energy efficient/ Flame proof motor	:	Yes/Yes (details shall be as per specification)

CLAUSE NO.	Bidder's Name .....

DE-	LT MOTORS	
A.	GENERAL	
1.	Manufacturer & Country of origin. (Shall be as per approved QA make)	
2.	Equipment driven by motor	
3.	Motor type	
4.	Quantity	
B.	DESIGN AND PERFORMANCE DATA	
1.	Frame size	
2.	Type of duty	
3.	Type of enclosure /Method of cooling/ Degree of	
4.	Applicable standard to which motor generally	
5.	Efficiency class as per IS 12615	
6.	(a)Whether motor is flame proof	Yes/No
	(b)If yes, the gas group to which it conforms as per IS:2148	
7.	Type of mounting	
8.	Direction of rotation as viewed from DE END	
9.	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard (KW)	
10.	Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
11.	Maximum continuous load demand of driven	
12.	Rated Voltage (volts)	
13.	Permissible variation of :	
	a. Voltage (Volts)	
	b. Frequency (Hz)	
	c. Combined voltage and frequency	
14.	Rated speed at rated voltage and	
15.	At rated Voltage and frequency:	
	a. Full load current	

CLAUSE NO.	Bidder's Name	
	b. No load current	
16.	Power Factor at	
	a. 100% load	
	b. NO load	
	c. Starting.	
17.	Efficiency at rated voltage and frequrecy,	
	a.100% load	
	b. 75% load	
	c. 50% load	
18.	Starting current (amps) at	
	a. 100 % voltage	
	b. 85% voltage	
	c. 80% voltage	
19.	Minimum permissible starting Voltage (Volts)	
20.	Starting time with minimum permissible voltage	
	a. Without driven equipment coupled	
	b. With driven equipment coupled	
21.	Safe stall time with 100% and 110% of rated	
	a. From hot condition	
	b. From cold condition	
22.	Torques :	
	a. Starting torque at min. permissible voltage(kg-	
	b. Pull up torque at rated voltage.	
	c. Pull out torque	
	d. Min accelerating torque (kg.m) available	
	e.Rated torque (kg.m)	
23.	Stator winding resistance per phase (ohms at 20	
24.	GD^2 value of motors	

CLAUSE NO.	Bidder's Name		
	25.	No of permissible successive starts when motor is in hot condition	
	26.	Locked Rotor KVA Input	
	27.	Locked Rotor KVA/KW	
	28.	Vibration limit :Velocity (mm/s)	
	29.	Noise level limit (dBA)	
	C.	**CONSTRUCTIONAL FEATURES**	
	1.	Stator winding insulation	
		a. Class & Type	
		b. Winding Insulation Process	
		c. Tropicalised (Yes/No)	
		d. Temperature rise over specified maximum ambient temperature of 50 deg C	
		e. Method of temperature measurement	
		f. Stator winding connection	
	2.	Main Terminal Box	
		a. Type	
		b. Location(viewed from NDE side)	
		c. Entry of cables(bottom/side)	
		d. Recommended cable size(To be matched with cable size envisaged by owner)	
		e. Fault level (MVA),Fault level duration(sec)	
		f. Cable glands & lugs details (shall be suitable for	
	3.	Type of DE/NDE Bearing	
	4.	Motor Paint shade	
	5.	Weight of	
		a. Motor stator (KG)	
		b. Motor Rotor (KG)	
		c. Total weight (KG)	

CLAUSE NO.	Bidder's Name .....

D.	**List of accessories.**	
1.	Space Heaters (Applicable for 30 KW & above motor) (Nos./Power in watts/supply voltage)	
2.	Terminal Box for Space Heater (Yes/No)	
3.	Speed switch (Yes/No)	
4.	Insulation of bearing (Yes/No)	
5.	Noise reducer(Yes/No)	
6.	Grounding pads	
	i) No and size on motor body	
	ii) Nos on terminal Box	
7.	Vibration pads	
	i) Nos and size	
	ii) Location	
8.	Any other fitments	
E.	**List of curves.**	
1.	Torque speed characteristic of the motor	
2.	Thermal withstand characteristic	
3.	Starting. current Vs. Time	
4.	Starting. current Vs speed	
5.	P.F. and Effi. Vs Load	
F.	**Additional Data to be filled for each rating of**	
1.	Rated armature voltage (Volt)	
2.	Rated field excitation (Amp)	
3.	Permissible % variation in voltage	
4.	Minimum Permissible Starting voltage (volt)	
5.	At rated voltage	
	i)Full load Armature current.(Amp)	
	ii)Full load Field current (Amp)	