CLAUSE NO.	TECHNICAL REQUIREMENTS
	(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. Handwheel shall be made of malleable iron with arms and rims of adequate strength. The handwheel 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 handwheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction. Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.
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.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	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 (d) **Austentic Ductile Iron (cast) Butterfly valves** Body & Disc — ASTM A 439 D2 and epoxy coated internals Shaft — SS - 316 Seat Rings — 18-8 Stainless steel Seal — EPT/BUNA/NEOPRENE / EPDM
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**

CLAUSE NO.	TECHNICAL REQUIREMENTS		
		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
		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-
	(5)	**Austentic Ductile Iron (Cast) Valves**	
		Body & bonnet	ASTM-A-439,D-2 (internals epoxy painted)
		Seating surfaces and rings	Stainless steel
		Disc for non-return valves	ASTM-A-439 D2 (epoxy painted)
		Hinge pin for non-return valves	AISI 316

CLAUSE NO.	TECHNICAL REQUIREMENTS
	Stem — Stainless steel Back seat — Stainless steel
	(b) Cast iron body valves shall have stainless steel stem and seat.
	(c) Material for counterflanges shall be the same as for the pipings.
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. In case of sea-water application the body of valve shall be to ASTM-A-439-D2.
	(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 colour code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface and Galvanised steel 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.
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

CLAUSE NO.	TECHNICAL REQUIREMENTS
	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. CO2 absorber vessel shall be provided with the initial fill of chemicals. Similarly for equipment cooling water overhead tank, the overflow & drain from tank shall be combined together and shall be led to nearest drain (at zero level) via. a seal-trough so as not to come directly in contact with atmosphere.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(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, DM Water tank etc. (e) For tank handling Sea-water, the internal surface of the tank in contact with Sea-water shall be having High build solvent free Poly-urethane coating of 2mm DFT generally following the guidelines of AWWA-C-222.
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 or polyurethane 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 colour for non-coastal environment. For coastal environment however, the outside surfaces of tanks shall be given 2 coats of epoxy based zinc phosphate primer of DFT 50 micron followed by an intermediate coat of Epoxy based TiO2 pigmented paint with DFT of 50 micron and finish coat of epoxy based paint of DFT 50 micron.

CLAUSE NO.	TECHNICAL REQUIREMENTS
2.22.05	~~Technical Particulars of Condensate Overhead Surge Tank.~~

~~Sl. No.~~	~~Description~~	~~Technical Particulars~~
~~(i)~~	~~Quantity per Unit~~	~~One (1)~~
~~(ii)~~	~~Useful Capacity of Each Tank~~	~~Not less than 150 Cu meter~~
~~(iii)~~	~~Size (Dia. x length)~~	~~Adequate~~
~~(iv)~~	~~Design Standard~~	~~ASME Section-VIII. Div. I/IS:2825 (Class 3)~~
~~(v)~~	~~Material Construction~~	~~MS Plates to IS: 2062 Gr. B/ASTM A36.~~
~~(v)~~	~~Accessories:~~	
	~~(a) Vent, overflow and drain~~	~~Required~~
	~~(b) Sampel Connection~~	~~Required~~
	~~(c) Level Indicator~~	~~Required (Gauge glass)~~
	~~(d) Level Transmitter~~	~~Required~~

~~Note: Number/capacity/size of tank are minimum for bidder's offer purpose. It is bidder's responsibility to design/size these tanks depending upon system requirement/design during detail engg. and submit the design calculation to Engineer for approval alongwith tank GA drg. Additional Control & Instrumentation facilities specified elsewhere in the technical specification shall also be incorporated by the bidder.~~

2.23.00	**RUBBER EXPANSION JOINTS**
2.23.01	All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
2.23.02	The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
2.23.03	The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
2.23.04	The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.

CLAUSE NO.	TECHNICAL REQUIREMENTS
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 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.
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

CLAUSE NO.	TECHNICAL REQUIREMENTS
	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 upto 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/sea-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 (SS-316 or Duplex S.S for Sea-water) upto 50 mm Nb, and IS:210, Gr. FG 260 or ASTM-A-515 Gr. 75/IS-2062 Gr. B (D2-Ni to ASTM-A-439 for Sea-water) and internally epoxy-painted above 50 mm NB.
	Strainer element — Stainless steel (AISI 316)
	End connection — Screwed upto 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. Such painting shall be suitable for coastal environment, if the equipment is installed in coastal project. 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.

FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES

FOR

SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS

(The term "Performance Guarantees" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)". ~~The term "TMCR" (Turbine maximum continuous rating) appearing in the Technical Specification shall mean 250 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 77 mm Hg (abs) 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 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 demonstrate all the guarantees covered herein during functional guarantee / acceptance test. The various tests which are to be carried out during performance guarantee/acceptance test are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Employer on each unit individually.

(d) All costs associated with the tests shall be included in the bid price.

(e) In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. However if the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit specified at clause 1.01.02 of this sub-section, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 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 of this sub-section shall be levied separately for each unit. The rates indicated in clause 1.01.02 of this sub-section are on per unit basis. The liquidated damages shall be pro-rated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category-I' Guarantees.

(ii) For Category-II Guarantees

Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

(iii) For Category-III Guarantees

Reject the equipment /system / plant and 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 guaranteed 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 in kcal/kWhr under rated steam conditions at 77 mm Hg (abs) design condenser pressure with zero make up at 250 MW unit load.~~

~~(ii) Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at 77 mm Hg (abs) design condenser pressure with zero make up at 200 MW unit load.~~

1.01.00 GUARANTEES UNDER CATEGORY – I

1.01.01 AMOUNT OF LIQUIDATED DAMAGES APPLICABLE FOR CATEGORY –1 GUARANTEES:-

If the performance guarantees specified at clause 1.01.01 are not met by contractor even after the modifications and / or replacements mentioned at clause 1.00.01(e) of this sub section but are achieved within the stipulated acceptable shortfall limit as indicated in this clause, employer will accept the equipments /systems/plant after levying liquidated damages ass indicated here under, however, if the demonstrated guarantees continue to be more than the stipulated acceptable shortfall limit, the employer may at his discretion accept the equipment / system only after levying liquidated damages against the contractor , at the rates listed herein, and such liquidated damages as shall be deducted from the contract price:

RATE FOR LIQUIDATED DAMAGE FOR POWER CONSUMPTION:-

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 @ US $ 2129 per KW increase in power consumption shall be levied.

Bidder to note that for penalty 1/3 of power consumption quoted by bidder shall be used.

1.02.00 GUARANTEES UNDER CATEGORY – II

NIL

1.03.00 GUARANTEES UNDER CATEGORY – III

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

1.03.01 Noise: - All the plant, equipment and systems covered under this specification hall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in annexure – 6, guaranteed performance data , section C3 of technical specification.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779. Sound pressure shall be measured all around the equipment at a distance of 1.0 meter horizontally from the nearest surface of any equipment / machine and at a height of 1.5 meter above the floor level in elevation.

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

2.00.00 PERFORMANCE GUARANTEE / ACCEPTANCE TEST:-

2.01.00 **GENERAL REQUIREMENTS:-**

2.01.01 It is responsibility of the contractor to perform the performance guarantee / acceptance test as specified in this sub section. The performance tests will be performed using only the normal number of employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used forinstructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

2.01.02 The Contractor shall make the plant ready for the performance guarantee tests.

CLAUSE NO.	FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES
2.01.03	All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation required for performance tests shall be supplied by the contractor and shall be retained by him upon satisfactory completion of all such tests at site. All costs associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the bid price. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes. Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.
2.01.04	The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following: (a) Object of the test. (b) Various guaranteed parameters & tests as per contract. (c) Method of conductance of test and test code. (d) Duration of test, frequency of readings & number of test runs. (e) Method of calculation. (f) Correction curves. (g) Instrument list consisting of range, accuracy, least count, and location of instruments. (h) Scheme showing measurement points. (i) Sample calculation. (j) Acceptance criteria. (k) Any other information required for conducting the test. The Performance / Acceptance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. After the conductance of Performance test, the contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one month from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Employer after completing each test run.
2.01.05	**Test Interruptions**

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	In the event of a test interruption resulting from an Event of Force Majeure or Employer-Caused-Delay, Contractor shall be entitled to relief as provided in the contract, provided that (except for certain interruptions of a Availability Test as specified below), the interrupted Performance Test must be started again and test data that were collected during the interrupted test must be ignored. In the event of test interruptions as a result of Force Majeure or Employer-Caused-Delay during an Availability test, where. (a) The total cumulative interrupted time during the test is more than twenty-four (24) hours. (b) The total number of interruptions during the test is more than four (4). The test shall not be deemed a successful Performance Test. Except as provided above, the interrupted test resulting from Force Majeure or Employer-Caused-Delay shall be extended by an amount of time equal to the length of the interruptions, including time to return to steady-state operation; the test data for the period of interruptions shall be excluded from analysis; and the test data that were collected both before and after the interruptions shall be included in the analysis.
~~2.01.06~~	~~**Grid Restriction**~~ ~~Any loss in generation in terms of power (KW) or energy (KWH) during Availability Test due to grid restrictions shall be treated as deemed generation. However, the total cumulative deemed generation shall not exceed 5% of the total generation during the test period failing which the test shall be extended to limit the deemed generation to 5% of the total generation.~~
~~2.02.00~~	~~**Turbine Generator Performance/ Acceptance Test**~~
~~2.02.01~~	~~Performance test for the turbine generator set will be conducted in accordance with the latest edition of ASME PTC-6. Such test shall be binding on the parties to the contract to determine compliance with the guaranteed heat balance conditions at 250 MW and 200 MW unit outputs corresponding to the conditions stipulated under Cl. 1.21.01 of Sub-section - A-3 (Turbine Generator and Auxiliaries), Part - B. Power consumed by the auxiliaries mentioned under clause 1.01.03 of this Sub - section which is to be deducted from electrical power generated, shall be measured during the performance / Acceptance Test. Wherever the measurement is not possible, design values of power consumption by an auxiliary shall be considered.~~
~~2.02.02~~	~~The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes. All the necessary instruments (in duplicate) required for the tests shall be furnished by the contractor so as to meet the accuracies specified in the codes. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the contractor, if required. For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap nozzle assembly including required machined straight lengths meeting the~~

(v) **Drip Pumps (if envisaged)**

(a) Each drip p ump shall b e capable o f delivering flow & total dynamic head corresponding to design point as specified.

(b) The vibration and noise level shall be demonstrated.

(vi) **Boiler feed pumps**

(a) Each boiler feed pump set shall be capable to deliver flow and total dynamic head corresponding to runout point as specified elsewhere.

(b) The vibration, noise level and para llel operat ion of any two of the three pumps shall be demonstrated as per specification requirements.

(vii) **Turbine hall EOT Crane :**

Over load test, travel & hoist spee d checks et c., shall be demonstrated as per IS: 3177 (latest edition).

1.03.05 **Equipment Cooling Water System (Unit Auxiliaries)**

i) Capacity, head & power consumption of all the pumps with the respective job (own) motors to be demonstrated at shop. For the pumps which are included under "Unit Auxiliaries for calculati on of Pu" as defined else where the power consumption value (at rated duty point) du ring shop testing shall be considered for computation.

ii) Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site.

iii) Design hea t load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exch angers on the prima ry and secondary side to be d emonstrated at site. Pre ssure drop across the Plate type heat exchanger on the primary & se condary water circu it t o be demonstrated at site.

1.03.06 **Hydrogen Generation Plant**

i) Power consumption, capacity & discharge pressure of hydrogen ga s compressors at its rat ed duty po int with its job (own) motor sha ll 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 g eneration plant capacity (stream wi se) shall be demonstrated at site. Vibration level an d noise level of hydrog en gas compressors sh all be demonstrated at site.

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	-	$7m^3$(app.)

7.0 WORKING PRESSURE - $150kg/cm^2$

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.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
	ELECTRICAL SYSTEM / EQUIPMENT
1.00.00	**GENERAL**
	The Bidder scope shall include design, manufacture, engineering, inspection & testing at supplier's works, packing, forwarding to site, unloading, erection , testing , commissioning and performance testing of the Electrical equipment / system and works indicated in this chapter. Unless explicitly stated to be common for all the units, the Bidder shall provide all system/equipment for each of the units. The electrical scope shall be described briefly in the following clauses, but not limited to it.
2.00.00	**GENERATOR AND AUXILIARY SYSTEM**
2.01.00	Generator complete in all respects including stator, rotor, bearings, couplings, terminal pads with palms and all its associated supervisory and instrumentation system.
2.02.00	Complete hydrogen cooling, carbon dioxide and nitrogen gas systems as applicable including the necessary piping and pipe supports, valves, measuring system alongwith the control panel and gas cylinders.
2.03.00	Complete seal oil system including the necessary tanks, pumps, motors, coolers, strainers, piping and pipe supports, valves, measuring system alongwith control panel.
2.04.00	Complete water cooling system where applicable including the necessary tanks, pumps, motors, heat exchangers, strainers, piping and pipe supports, valves, measuring system alongwith control panel.
2.05.00	Complete excitation system (brushless or static type) with main excitor, excitation transformer, thyristor, pilot excitor, rectifiers and filters, field flashing and field forcing equipment, rotating diodes etc. as applicable alongwith the DAVR, deexcitation equipment, cables/bus duct and all necessary control, annunciation and monitoring equipment mounted on suitable panels.
3.00.00	**MOTORS**
	Motors along with couplings and coupling guards for all rotating auxiliaries covered under this package.
4.00.00	**LT Switch Gear**
	i) Hydrogen Generation plant MCC
	ii) DC motor starter panels including starting resistors
	iii) Starter panels for the following
	a) Oil purification system of each TG unit

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
	b) Central oil purification system for TG c) Condenser on load tube cleaning system iv) Local Emergency push button (PB) stations for all drives energised from MCC's under contractor scope.
5.00.00	**CABLES AND CABLING**
5.01.00	All LT power & control cables required for connection between equipment/devices in contractors scope.
5.01.01	a) Employer will supply and erect the cable trays and its supporting structure in the main cable routes both for employer's cable and contractor's cable covered in Electrical and C&I section. Employer will provide main cable tray route upto the drives/ major equipments/ panels. Contractor shall provide the branch route along with tray and support arrangements for the cables under his scope of supply from instruments/ equipments to local junction box and from local junction box to the nearest main routes. Contractor shall keep the space for employer's cable in the branch routes. However, in case of hydrogen generation plant, contractor shall supply and erect complete galvanised cable trays and its prefabricated bolted type flexible galvanised supporting structure including for employer's incoming cables within hydrogen plant building. b) Contractor shall furnish the tentative cable tray routing indicating the contractor's tray requirement/location of equipment. Contractor shall keep the provision of the loads for the above tray routes in their structures. c) Employer shall prepare the cable tray routing based on the contractor's input like tentative cable tray layout, final equipment layout etc. Employer shall furnish the cable tray routing to contractor for review and clearance by contractor. d) Contractor shall furnish the cable list as per mutually agreed format for all the cables under his scope of supply under electrical and C&I section, to the employer to prepare the cable schedule. e) Contractor will lay and terminate the cables under his scope of supply on the main tray route to be provided by the employer and branch routes to be provided by the contractor. Contractor shall provide all accessories such as rigid/ flexible conduits, fittings, junction boxes, tying materials, cable tags, markers etc. for the cables under his scope. Contractor shall provide cable glands and lugs for all equipments in his scope. f) Interconnection diagram for cables between contractor's equipments shall be prepared by the contractor. g) The contractor shall furnish the complete and final feeder list for LT system and HT system for all loads and drives under the scope of supply of contractor to employer in advance and as per mutually agreed schedule.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
6.00.00	**LIGHTING**
6.01.00	Complete lighting for internal and external areas of hydrogen generation plant building.
7.00.00	**EARTHING AND LIGHTNING PROTECTION**
7.01.00	Complete overground earthing and lightning protection for hydrogen generation plant equipment and building.
8.00.00	**ELECTRICAL ACTUATORS**
	Electric actuators with integral starters along with associated accessories etc shall be supplied on as required basis for Valves / Dampers to meet the functional and the other specification requirements.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	MOTORS
1.00.00	**GENERAL REQUIREMENTS**
1.01.00	For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% shall be considered. The equipment shall operate in a highly polluted environment.
1.02.00	All equipments shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.
1.03.00	Contractor shall provide fully compatible electrical system, equipments, accessories and services.
1.04.00	All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.
1.05.00	The auxiliary AC voltage supply arrangement shall have 6.6 kV and 415V systems. It shall be designed to limit voltage variations as given below under worst operating condition : (a) 6.6 kV +/- 6% (b) 415/240V +/- 10%
1.06.00	The voltage level for motors shall be as follows :- a) Upto 0.2KW : Single phase 240V AC / 3 phase 415V AC b) Above 0.2KW and upto 200KW : 3 phase 415V AC c) Above 200KW : 6.6 kV
1.07.00	Fault level shall be limited to 40kA RMS for 1 second for 6.6 kV system and 45 kA RMS 1 second for 415V system. 415V system shall be solidly grounded and 220 VDC system shall be isolated type.
1.08.00	Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.
1.09.00	The responsibility of coordination with electrical agencies and obtaining all necessary clearances shall be of the contractor.
1.10.00	Degree of Protection Degree of protection for various enclosures as per IS:13947 shall be as follows :- i) Indoor motors - IP 54

CLAUSE NO.	TECHNICAL REQUIREMENTS
	ii) Outdoor motors - IP 55
	iii) CW motors (in case of screen prot. Drip proof) - IP 23
2.00.00	**CODES AND STANDARDS**
	1) Three phase induction motors : IS:325, IEC:60034
	2) Single phase AC motors : IS:996, IEC:60034
	3) Crane duty motors : IS:3177, IEC:60034
	4) DC motors/generators : IS:4722
3.00.00	**TYPE**
3.01.00	**AC Motors:**
	(a) Squirrel cage induction motor suitable for direct-on-line starting.
	(b) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.
3.02.00	DC Motors Shunt wound.
4.00.00	**RATING**
	(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.
	(b) Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.
5.00.00	**TEMPERATURE RISE**
	Air cooled motors
	70 deg. C by resistance method for both class B&F insulation.
	Water cooled
	80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both class B&F insulation.

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.00.00	**OPERATIONAL REQUIREMENTS**
6.01.00	**Starting Time**
6.01.01	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.
6.01.02	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.
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
6.02.00	**Torque Requirements**
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
6.02.02	Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
6.03.00	**Starting voltage requirement** (a) 85% up to 1500KW (d) 80% from 1501 KW to 4000KW (e) 75% > 4000KW
7.00.00	**DESIGN AND CONSTRUCTIONAL FEATURES**
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors , space heater terminals inside the main terminal box may be acceptable.
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below (a) Fuel oil area : Group – IIB (b) Hydrogen generation plant area : Group - IIC (or Group-I, Div-II as per NEC)

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.03.00	Winding and Insulation (a) Type : Non-hygroscopic, oil resistant, flame resistant (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature. However, conveyor motors shall be suitable for 3 consecutive hot starts followed by one hour interval at standstill with maximum 20 starts per day and minimum 20,000 starts during life time of motor. (c) 6.6 kV AC motors : Class F , with winding temperature rise limited to class B. The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. They shall withstand 1.2/50 microsec. switching surges of 4U+5 KV (U=Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3 micro sec. surge of 20 KV . (d) 240VAC, 415V AC & 220V DC motors : Class B or better (e) Short circuit rings of conveyor motors shall be either jointless or welded type. Brazed joint is not acceptable.
7.04.00	Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
7.06.00	Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits prescribed in IS:12075 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and 2 numbers duplex platinum resistance type temperature detectors.
7.08.00	Motor body shall have two earthing points on opposite sides.
7.09.00	HT motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves

CLAUSE NO.	TECHNICAL REQUIREMENTS
	shall also be provided. In case cable box is offered, then Employer shall provide termination kit. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.
7.10.00	The spacing between gland plate & centre of terminal stud shall be as per Table-I.
7.11.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.12.00	The motors shall be suitable for bus transfer schemes provided on the 6.6 kV /415V systems without any injurious effect on its life.
7.13.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.14.00	6.6KV motor Terminal Box shall be suitable for fault level of 500MVA for 0.12 sec.
7.15.00	The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.
7.16.00	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 1500KW: 10.0 (c) Above 1500KW & upto 4000KW: 9.0 (d) Above 4000KW: 6 to 6.5
8.00.00	**TYPE TEST**
8.01.00	**HT MOTORS**
8.01.01	The contractor shall carry out the type tests as indicated in the "LIST OF TYPE TESTS TO BE CONDUCTED " on the equipment mentioned there in. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Owner's Engineer.
8.01.02	The type tests shall be carried out in presence of the Owner's representative, for which minimum 15 days notice shall be given by the Contractor. The Contractor shall obtain the Owner's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.01.03	In case the contractor has conducted such specified type test(s) within last five years as on the date of bid opening, he may submit the reports of the type tests indicated in the "LIST OF TYPE TESTS TO BE CONDUCTED " to the owner for waival of conductance of such type test(s).These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Owner reserves the right to waive conducting of any or all of the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
8.01.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.
8.01.05	**LIST OF TESTS TO BE CONDUCTED** **The following type tests shall be conducted on each type and rating of HT motor** (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary overload test (subject to test bed constraint). (d) Full load test (subject to test bed constraint). (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose. (f) Surge withstand test on the sample coil after placing it in stator core at (4U + 5 KV) and with at least five impulse of 1.2/50 micro sec. Wave, where U is the line to line voltage in kV. (g) Surge-withstand test at 20 KV with 0.3/3 micro sec. wave on each type of 6.6 kV motor coils respectively with at least five such impulses

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.01.06	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** **The following type test reports shall be submitted for each type and rating of HT motor** (a) Degree of protection test for the enclosure followed by IR, HV and no load run test. (b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.
8.02.00	**LT Motors**
8.02.01	LT motors shall be of type tested quality. For each type & rating of LT motors rated above 50 KW, the contractor shall submit for Owner's approval the reports of all the type tests as per relevant standards and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
8.02.02	In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.
8.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

CLAUSE NO.	TECHNICAL REQUIREMENTS

TABLE - I

DIMENSIONS OF TERMINAL BOXES

FOR LV MOTORS:

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

FOR HT MOTORS:

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

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

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

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

CLAUSE NO.	TECHNICAL REQUIREMENTS
	LT POWER CABLES
1.00.00	**CODES & STANDARDS**
1.01.00	All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:
	IS :1554 - I — PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.
	IS : 3961 — Recommended current ratings for cables
	IS : 3975 — Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
	IS : 4905 — Methods for random sampling.
	IS : 5831 — PVC insulation and sheath of electrical cables.
	IS : 7098 (Part -I) — Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.
	IS : 8130 — Conductors for insulated electrical cables and flexible cords.
	IS : 10418 — Specification for drums for electric cables.
	IS : 10810 — Methods of tests for cables.
	ASTM - D - 2843 — Standard test method for density of smoke from the burning or decomposition of plastics.
	IEC - 754 (Part-I) — Test on gases evolved during combustion of electric cables.
	IEC - 332 — Tests on Electric cables under fire conditions. Part-3 : Tests on bunched wires or cables (catagory -B)
2.00.00	**TECHNICAL REQUIREMENTS**
2.01.00	The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground burried installation with chances of flooding by water.
2.02.00	Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

CLAUSE NO.	TECHNICAL REQUIREMENTS
2.03.00	Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.
2.04.00	XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg.C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.
2.05.00	The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.
2.06.00	For single core armoured cables, armouring shall be of aluminium wires. For multicore armoured cables armouring shall be of galvanised steel as follows : -

	Calculated nominal dia of cable under armour	**Size and Type of armour**
i)	Upto 13 mm	1.4mm dia GS wire
ii)	Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii)	Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
iv)	Above 40 & upto 55mm	1.4 mm thick GS formed wire / 2.5mm dia GS wire
v)	Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi)	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The gap between armour wire / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface.

2.07.00 Outer sheath shall be of PVC(of suitable grade) & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

(a) Oxygen index of min. 29 (As per IS:10810 (part-58))

(b) Acid gas emission of max. 20% (As per IEC-754-I).

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.
2.08.00	Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted: 1 core - Red, Black, Yellow, Blue 2 core - Red & Black 3 core - Red, Yellow & Blue 4 core - Red, Yellow, Blue and Black
2.09.00	For reduced neutral conductors the core shall be black.
2.10.00	In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath. 1) Cable size and voltage grade - To be embossed 2) Word 'FRLS' at every 5 metre - To be embossed 3) Sequential marking of length of the cable in metres at every one metre. - To be embossed / printed The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.
2.11.00	All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part -3.
2.12.00	Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets.
2.13.00	In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc.are not acceptable.
2.14.00	**Cable selection & sizing**
2.14.01	LT Power cables shall be sized based on the following considerations: (a) Rated current of the equipment (b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage (c) Short circuit withstand capability This will depend on the feeder type. For a fuse protected circuit, cable should

CLAUSE NO.	TECHNICAL REQUIREMENTS
	be sized to withstand the let out energy of the fuse.For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time. (d) The minimum conductor size shall be 6 sqmm for aluminium conductor cables and 2.5 sqmm for copper conductor cables. The constructional details of copper conductor cables shall be same as indicated for copper control cable.
2.14.02	Derating Factors Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes: a) Variation in ambient temperature for cables laid in air b) Grouping of cables c) Variation in ground temperature and soil resistivity for buried cables.
2.14.03	Cable lengths shall be considered in such a way that straight through cable joints are avoided.
2.14.04	Cables shall be armoured type if laid in switchyard area or directly buried.
2.14.05	All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated and preferable sizes are 1Cx150, 1Cx300, 1Cx630, 3Cx150 & 3Cx240 sq.mm.
3.00.00	**CONSTRUCTIONAL FEATURES**
3.01.00	**1.1 KV Grade Power Cables** (a) 1.1 KV grade XLPE power cables shall have compacted aluminium conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured/ unarmoured, PVC outer-sheathed conforming to IS:7098. (Part-I). (b) 1.1KV grade PVC power cables shall have aluminium conductor(compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) armoured/ unarmoured, PVC outer-sheathed conforming to IS:1554 (Part-I). (c) 1.1 KV grade Trailing cables shall have tinned copper(class 5)conductor, insulated with heat resistant elastomeric compound based on Ethylene Propyline Rubber(EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.02.00	**Cable Drums** (a) Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS : 10418. (b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.
4.00.00	**TESTS**
4.01.00	**GENERAL** 1.0 All equipments to be supplied shall be of type tested quality. 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 five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. 2.0 In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval. 3.0 All acceptance and routine tests as specified below and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

CLAUSE NO.	TECHNICAL REQUIREMENTS
4.02.00	**TYPE TESTS:**
4.02.01	The type tests reports for the following shall be submitted on one size each of PVC / XLPE LT Power cables :

S. No.	Type Test	Remarks
a)	For Conductor	
1.	Resistance test	
b)	**For Armour Wires / Formed wires**	
2.	Measurement of Dimensions	
3.	Tensile Test	For aluminium wires also
4.	Elongation test	For aluminium wires also
5.	Torsion test	For round wires only
6.	Winding test	For Formed wires only
7.	Resistance test	For aluminium wires also
8.	Zinc Coating test	For G.S. Formed wires /wires only.
c)	**For PVC/XLPE insulation & PVC Sheath**	
9.	Test for thickness	
10.	Tensile strength & elongation tests before ageing and after ageing	
11.	Ageing in air oven	
12.	Loss of mass test	For PVC insulation and sheath only
13.	Hot deformation test	For PVC insulation and sheath only
14.	Heat shock test	For PVC insulation and sheath only
15.	Shrinkage test	
16.	Thermal stability test	For PVC insulation and sheath only
17.	Hot set test	For XLPE insulation only
18.	Water absorption test	For XLPE insulation only
19.	Oxygen index test	For outer sheath only

CLAUSE NO.	TECHNICAL REQUIREMENTS	
	20. Smoke density test	For outer sheath only
	21. Acid gas generation test	For outer sheath only
	d) **For completed cables**	
	22. Insulation resistance test (Volume resistivity method)	
	23. High voltage test	
	24. Flammability test as per IEC - 332 Part-3 (Category -B)	
4.02.02	**Acceptance Tests** (as per QA table)	
4.03.00	**Routine Tests** (as per QA table)	

CLAUSE NO.	TECHNICAL REQUIREMENTS
	LT CONTROL CABLES
1.00.00	**CODES & STANDARDS**
1.01.00	All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes :
	IS :1554 - I — PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.
	IS : 3961 — Recommended current ratings for cables
	IS : 3975 — Low carbon galvanised steel wires, formed wire and tapes for armouring of cables.
	IS : 4905 — Methods for random sampling.
	IS : 5831 — PVC insulation and sheath of electrical cables.
	IS : 8130 — Conductors for insulated electrical cables and flexible cords.
	IS : 10418 — Specification for drums for electric cables.
	IS : 10810 — Methods of tests for cables.
	ASTM-D -2843 — Standard test method for density of smoke from the burning or decomposition of plastics.
	IEC-754 (Part-I) — Test on gases evolved during combustion of electric cables.
	IEC -332 — Tests on Electric cables under fire conditions Part-3 : Tests on bunched wires or cables (category -B)
2.00.00	**TECHNICAL REQUIREMENTS**
2.01.00	The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground burried installation with chances of flooding by water.
2.02.00	Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.
2.03.00	Conductor of control cables shall be made of multi stranded, plain annealed copper.