3.01.00 **Codes and Standards**

3.01.01 All cable and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

3.01.02 Cable and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.02.00 **Erection Schedule**

3.02.01 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the tenderer for this purpose.

3.02.02 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the Bidder. If, for any reason beyond the control of the Bidder, the work is held-up then the Bidder shall bring it to the notice of the Owner's Engineer without any delay.

4.00.00 DESIGN CRITERIA

4.01.00 **Grounding System**

4.01.01 The main objectives of grounding system are to:

a) Provide safety to personnel from contact of dangerous potential caused by ground fault.

b) Ensure sufficient grounding current for effective relaying.

c) Stabilize circuit potential with respect to ground.

d) The grounding system shall be designed in compliance with the IEEE-80/ IEEE- 665 considering fault current of 50kA for 1 sec. and shall be subject to approval of the Owner.

e) Major items of equipment, such as switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the underground grid.

f) Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation

4.02.04 For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections.

4.02.05 **System Design**

a) Air termination network with down conductors and earthing electrodes shall be provided on the basis of IS Code of Practice.

b) Horizontal air termination shall be so laid out that no part of the roof shall be more than 9 meters from the nearest conductor.

c) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.

d) Down conductors shall run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground.

e) An earth electrode shall be provided at the connection point of the down conductor with the station ground.

f) Galvanised steel rods and flats shall be generally used for air termination and connections. All connections shall be welded type.

g) All other ancillary items in connection with the work described above shall be furnished to complete the work irrespective of whether such items may have been specifically mentioned or not.

4.02.06 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

4.03.00 **Cabling System**

4.03.01 Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply system to all FGD auxiliaries.

4.03.02 Cable routing shall be done on unit basis as far as possible.

4.03.03 Cables shall generally be laid on cable trays overhead supported from building steel/structures. Cables shall be run in concrete trenches in those electrical rooms at ground level, which are without any spreader room below.

4.03.04 For inter plant connections, the cables shall be routed through an overhead cable bridge pipe cum cable bridge. For isolated but long outdoor cable route with very few cables of 3/4 nos., the cables may be directly buried subject to Owner's approval.

4.03.05 For underground crossing of railways, road etc. additional protection shall be provided in form of hume pipe or concrete encased rigid steel conduits (duct bank).

4.03.06 A.C. and D.C. circuit shall not be run in same cable. Further, separately fused circuit shall run in separate cables.

4.03.07 Cables for redundant equipment system shall be run in separate trays, as far as possible.

4.03.08 Erection of cabling work shall be executed keeping in view all necessities and requirements.

4.03.09 Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays in addition to normal tray cable loadings.

4.03.10 All erection work to be carried out under this specification shall conform to the notes and details given in Annexure-A to this specification.

5.00.00 SPECIFIC REQUIREMENTS - SUPPLY

5.01.00 Equipment and Material

5.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.

5.01.02 Equipment and materials furnished shall be complete and operative in all details.

5.01.03 All accessories, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

5.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

5.03.00 Conduits and Accessories

5.03.01 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.

5.03.02 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

5.02.03 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the

exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.02.04 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.

5.02.05 Flexible conduits complying to relevant IS and made with bright, cold-rolled, annealed and electro-galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.

5.02.06 Non-metalic conduits made of HDPE outer jacket with friction-reducing permanent internal lining shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and where the runs are straight ones Necessary fittings & accessories as may be required for the installation shall also be provided.

5.03.00 **Junction Boxes**

5.03.01 Technical requirement for both non-metallic type and galvanized steel Junction Boxes are given below. Unless the choice is specifically mentioned in the General / Lead Electrical Specification or elsewhere in the tender document, galvanized steel Junction Boxes shall be offered.

5.03.02 Non-metallic Junction Boxes

a) Material of the Junction Boxes shall be halogen-free and silicon-free, glass fibre-reinforced polycarbonate for outdoor use and/or for cable sizes more than 50 sq.mm. Material shall be ABS/ polycarbonate for indoor use and/or for cable sizes upto 50 sq. mm. Junction boxes for use with fire-survival cables shall be of Duro-plast / powder-coated metal.

b) Material of all non-metallic junction boxes shall be fire retardant and self-extinguishing in accordance with UL 94 V0. It should be tested at Glow Wire test for 960° C.

c) Boxes shall be suitable for continuous operation at an ambient temperature range of -10° C to +80° C.

d) The impact strength of polycarbonate enclosures/boards i.e. the degree of protection against mechanical shock load shall be in accordance with EN 50298-98 for IK 08 (5 Joule).

e) Degree of protection shall be IP 66 to EN 60529. Junction boxes shall have integrally embedded gaskets made of Polyurethane.

f) Allowing a minimum of 20% spare terminals after complete termination, the terminal board for control and instrumentation JBs shall have 6 /12 / 24 / 36 / 48 ways.

g) Doors shall have stainless steel quick fastening screws.

h) The boxes shall be complete with all brackets/fasteners as required for installation on walls, columns and structure.

5.03.03 Steel Junction Boxes

a. Junction boxes with IP 55 degree of protection, shall comprise of a rectangular parallelepiped case constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the box shall be arranged to slope towards the rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanized as per relevant IS, and suitable for mounting on wall, column, structures etc. The boxes shall be complete with M8 earthing stud and all brackets/fasteners as required for installation.

b) No. of Ways:6 / 12 / 24 / 36 / 48 with 20% spare terminals after termination.

c) Outdoor JBs shall be similar but with a canopy at the top.

d) Doors shall be hinged and lockable and shall be made of the same material as the case. The doors shall have industrial heavy-duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.03.04 **The junction boxes shall have the following indelible markings:**

- Circuit nos. on top by white-stenciled paint at site.
- Circuit nos. with ferrules (inside) as per approved drawing.
- Danger sign in case of 415 V circuit.

5.04.00 **Terminals**

5.04.01 Multiway terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

5.04.02 Each control cable terminal shall be suitable for connection of 2 nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.

5.05.00 **Cable Termination & Straight Through Joints**

5.05.01 Bidder shall supply cable termination and jointing kits in requisite quantity for H.T. Power Cables, L.T. Power, Control Cables, Instrumentation Cables, etc. along with all accessories & consumables required for making termination and joints complete. Those shall be of proven design and make which have already been extensively used and type tested.

5.05.02 Components shall be pre-moulded type, taped type or heat-shrinkable type. 11kV, 6.6kV and 3.3kV grade joints and terminations shall be type tested as per IS: 13573.

5.05.03 Kits shall be complete with the alumunium solderless crimping type cable lugs and ferrule as per DIN standard.

5.06.00 **Cable Glands**

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS 6121 or to EN 50262. Ingress Protection rating for cable glands with seal, when offered conforming to EN 50262, shall be minimum IP 66 in line with BS. Cable glands shall be made of tinned brass gland, double compression type complete with necessary armour clamp and tapered washer, etc. Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall match with the sizes of different H.V./L.V./Control cables supplied/erected.

5.07.00 **Cable Lugs**

All cable lugs shall be Cd plated copper. Cable lugs shall be suitable for termination of different cross-sections of H.V./L.V./Control/Instrumentation cables and shall be of following types :

i) Aluminium tubular terminal end for solderless crimping to aluminium conductors.

ii) Copper tubular terminal end for solderless crimping to copper conductors.

Solderless crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

iii) Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ring type/U type to suit the terminals provided in the panels.

5.08.00 **Cable Clamps and Straps**

5.08.01 Trefoil clamps for single core cables shall be pressure die-cast aluminium or fibre glass or nylon with necessary G I fasteners. Trefoil clamps shall have adequate mechanical strength to forces generated by peak value of maximum system short circuit current.

5.08.02 Cable clamps required for multicore cables on vertical run shall be made up of 25x3mm size aluminium strip. For clamping the multicore cables, self-

locking, de-interlocking type fire-resistant nylon clamps/straps of sufficient strength shall be used.

5.09.00 **Consumables and Hardware**

5.09.01 The Bidder shall furnish all erection materials, hardware and consumables required to complete the installation.

5.09.02 The materials shall include but not be limited to the following :

Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.

Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

5.09.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

5.10.00 **Testing Equipment**

5.10.01 The major testing equipment that are required to be arranged by the Bidder for site testing are listed below:

a) **Insulation Tests**

i) Power operated Meggar - 1 KV and 10 KV grade

ii) Hand operated Meggar - 1 KV grade

b) Hand driven earth Resistance Meggar, range 0-1/3/30 ohms.

c) High potential testing set - roller mounted type

d) Tong testers of suitable ranges.

e) Contact resistance measuring set for micro-ohms.

f) Torque wrench of various sizes.

g) Multi meters, test lamp, field telephone with buzzer set, different gauges etc.

5.10.02 The list of equipment is indicative only. Any other test equipments required shall be arranged by the Bidder.

6.00.00 METHODS AND WORKMANSHIP

6.01.00 All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.

6.02.00 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

6.03.00 All details on installation shall be electrically and mechanically correct.

6.04.00 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

7.00.00 INSTALLATION

7.01.01 Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instructions/ recommendations where the same are available.

7.01.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.01.03 Cable installation work shall mean erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches tunnels/overhead trays in conduits etc. dressing and clamping, jointing and termination inclusive of supply of necessary jointing/termination kits, lugs, glands, ferrules, tapes etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.

7.01.04 Grounding installation work shall mean erection, jointing/brazing/welding, connection and painting, testing of ground conductors including supply of necessary steel/copper.

7.01.05 Lightning protection system installation work shall mean erection, jointing, welding, connection and painting, testing of air termination network, down conductors, shielding masts, connection to ground grid, electrodes, risers, horizontal conductors etc. of lightning protection system.

7.02.00 **Cable Trays**

7.02.01 Pre-fabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces shall be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

7.02.02 Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings.

7.02.03 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

7.02.04 The cable trays shall be supported in general at a span of not exceeding 1.5 metres horizontally and 1.0 metre vertically.

7.02.05 Sufficient spacing not less than 250 mm shall be provided between trays and maintained to permit adequate access, for installing & maintaining the cables..

7.02.06 Complete cable tray support structure after installation shall be inspected/ tested for welding strength, straightness, accuracy, use of proper sizes and compliance to drawings.

7.02.07 Complete cable tray and accessory installation work shall be inspected/tested for proper alignment, leveling, use of proper accessories, high quality workmanship etc.

7.02.08 The Bidder shall remove the RCC/steel trench covers whenever required and shall again place the same in their positions after the erection work in the particular area is completed or when further work is not likely to be taken up for some time.

7.02.09 Whenever any pipe/conduit/cable tray emerges out or enters into a building care should be taken to ensure that no water enters into the building.

7.02.10 Cable trays in areas subject to excessive coal dust, oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.

7.02.11 Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way.

7.02.12 Cable tray/conduit system shall be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.

7.02.13 Cable tray/conduit system shall be constructed to prevent drainage of water into equipment or building.

7.02.14 Cable tray/conduit system shall be electrically continuous and grounded.

7.02.15 Different voltage grade cables shall be laid in separate trays when trays are run in tier formation. Power cables shall normally be on top trays and control/instrumentation cable on bottom trays.

7.02.16 Trenches

i) PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

ii) No subzero level cable vault/trenches shall be provided below control building/switchgear rooms in FGD areas.

7.03.00 **Cable and Conduits**

7.03.01 The Bidder shall install, terminate and connect up all cable and conduits as per drawings and cable schedules.

7.03.02 The drawings shall be strictly followed except where obvious interference occurs. In such cases, the routing shall be changed as directed and/or approved by the Engineer.

7.03.03 Approximate lengths of cable and conduit runs shall be shown by the Bidder in the cable schedule for guidance only. Before commencement of work the Bidder shall take actual measurements and prepare his own cable-cutting schedule to reduce wastage to a minimum.

7.03.04 The Bidder shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/jointing.

7.03.05 Where direct heat radiation exists, heat isolating barriers, shall be adopted for cabling system.

7.03.06 Cabling/wiring in offices, laboratories, control rooms etc. shall be taken through concealed G.I. or rigid PVC pipes as directed by the Owner's Engineer.

7.03.07 At certain places where hazardous fumes/gasses may cause fire to the cables, cable trenches after installation of cables shall be sand filled.

7.04.00 **Conduit and Accessories**

7.04.01 Conduit/pipes shall be used only in short lengths in certain areas where required and/or as directed by the Engineer.

7.04.02 The Bidder shall furnish all conduits complete with accessories as required.

7.04.03 Conduits shall be flexible type in general. However, rigid type steel conduit if required shall also be supplied by the Bidder.

7.04.04 Except for inside an enclosure wherever the cable enters or leaves the conduit, the conduit end shall be sealed by suitable sealing compound, having fire withstand capability.

7.04.05 The entire metallic conduit system, when embedded or exposed shall be electrically continuous and grounded.

7.04.06 Where it is possible for water or other liquids to enter conduits, sloping of conduit runs and drainage of flow points shall be considered.

7.04.07 Pull boxes shall be installed between termination points where required to facilitate cable pulling, but at a maximum interval of 30 meters.

7.04.08 Conduits shall be firmly fastened within 900 mm of each junction box/pull box/cabinet/fitting etc. Conduits shall be supported at least every 2000 mm.

7.05.00 **Cables: Storage and Handling**

7.05.01 Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e., with flange horizontal.

7.05.02 Rolling of drums shall be avoided as far as practicable, for short distance, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

7.05.03 In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.

7.05.04 For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending.

7.05.05 The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.

7.05.06 While laying cable, cable rollers shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be used. Cables shall not be dragged on ground or along structure while laying out from cable drums.

7.05.07 Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.

7.05.08 Empty cable drums shall be returned to the Owner.

7.06.00 **Cable Laying**

7.06.01 Cable shall generally be installed in ladder type prefabricated trays except for some short run in rigid/flexible conduit for protection or crossings.

7.06.02 Cables laid on trays and risers shall be neatly dressed and clamped with self-locking type fire resistant nylon ties at an interval of 750 mm for horizontal and vertical runs, in case of both power, control and instrumentation cables.

7.06.03 All single core power cables for 3 Ph. AC circuits shall be laid in trefoil formation and suitably clamped with self-locking type fire resistant nylon ties at an interval of 750mm.

7.06.04 L.T. multicore power cables with cross-sectional area of 95 sq.mm and above and all H.T. multicore power cables and shall be clamped individually by self-locking type fire resistant nylon ties.

7.06.05 L.T. power cables of cross sectional area less than 95 sq.mm and all control and Instrumentation cables shall be clamped in bunches with self-locking type fire resistant nylon ties. The number of cable in one bunch shall not exceed eight (8).

7.06.05 Prior to laying of cables inside the indoor and outdoor trenches, the Bidder shall properly clean the trenches.

7.06.06 In outdoor areas, buried cables shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.

7.06.07 When buried cables cross road/railway track, adequate protection shall be provided in the form of hume/ galvanised iron pipes laid at a minimum depth of 1 meter below ground.

7.06.08 After completion of installation and prior to connection, all power cables shall be subjected to a high potential test.

7.07.00 **Cable Fire Sealing**

7.07.01 Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be seated by a fire proof sealing system (FPSS) of minimum 2 Hrs rating. The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

7.07.02 Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for two hour shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

7.08.00 **Cable Laying in Trenches**

7.08.01 RCC cable trenches with removable covers shall be provided by the Contractor. Cables shall be laid in 3 or 4 tires in these trenches RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the Contractor at no extra cost.

7.08.02 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.

7.08.03 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover tilt such times the final termination to the equipment is completed.

7.08.04 Prior to laying of cables inside both indoor and outdoor trenches, the Contractor shall properly clean inside of those trenches.

7.08.05 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer.

7.08.06 As each row of cables is laid in place every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

7.08.07 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.

7.08.08 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.

7.08.09 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

7.08.10 Following guide of the pipe fill shall be used for sizing the pipe size:-

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 51% full

c) 3 or more cables - 40% full

7.08.11 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.

7.08.12 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings shall be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical Contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

7.09.00 **Cable Tags & Markers**

7.09.01 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, bends, every 30.0M and exit from any equipment, junction box. When a cable/conduit passes through a wall, tags shall be fitted on both sides of the wall.

7.09.02 The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. For single core cable the wire shall be of non-magnetic material.

7.09.03 Location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription 'cable-joint'.

7.09.04 Contractor shall furnish and install all tags and markers stated above.

7.09.05 For buried cable, the marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction.

7.10.00 Cable Termination and Connection

7.10.01 Termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, drawings and/or as directed by the Engineer.

7.10.02 Work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be of Contractor's procurement. Furnishing of all consumable materials such as soldering material, electrical tape, sealing material as well as cable jointing kits shall be included in the offer.

7.10.03 Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by Contractor.

7.10.04 The equipment will be generally provided with blank bottom plates for cable/conduit entry and cable end box for power cables.

7.10.05 The bidder shall perform all drilling, cutting on the blank plate and any minor modification work required to complete the job.

7.10.06 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the contractor.

7.10.07 Control/instrumentation cable cores entering control panel/ switchgear/ MCC, etc. shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

7.10.08 The bidder shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.

7.10.09 Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number.

7.10.10 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

7.10.11 All cable entry points shall be properly sealed and made vermin and dust proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

7.10.12 Strips and special tools like manually or pneumatically driven gun/pistol for termi point/equivalent connection shall be supplied by the Contractor.

7.11.00 **Cable Joints**

7.11.01 Cable shall be installed without joints as far as practicable.

7.11.02 If however jointing becomes necessary, it shall be made only by qualified cable jointer and strictly in accordance with manufacturer's recommendation.

7.12.00 **Grounding**

7.12.01 The Bidder shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules Indian standards and enclosed grounding and lightning protection notes and details.

7.12.02 Grounding shall be done by conductors of adequate sizes (size shall be selected by the bidder with supporting calculation, if not specified) and the same shall be connected to the risers of main ground mat.

7.12.03 For fabricated cable trays, a separate ground conductor (50x6 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be connected to above ground conductor through 50x6 mm G.S. flat to maintain continuity of ground path.

7.11204 All ground conductor connections shall be made by electric arc welding/ brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers. The rods/connection shall be coated with cold galvanizing /weather resistance anti corrosive paints.

7.12.05 All ground conductors shall be painted black for easy identification.

7.12.06 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint.

7.17.02 Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

8.00.00 TESTS

8.01.00 **Shop Tests**

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on panels/junction boxes shall include:

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

8.02.00 **Site Tests**

8.02.01 Bidder shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All power cables after installation and prior to connections shall be subjected to High Potential tests. Also the insulation resistance values shall be measured both before and after Hipot test for comparison. The leakage current shall also be measured during the Hipot test at site.

Cable cores shall be tested for:

a) Physical damage

b) Continuity

c) Correctness of connections as per relevant wiring diagram

d) Insulation resistance to earth

e) Insulation resistance between conductors

f) Proper earth connections of cable glands, cable boxes, cable armour, screens etc.

8.02.04 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.03.00 **Test Certificates**

8.03.01 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 DRAWINGS, DATA & MANUALS

9.01.00 **To be submitted with the Bid**

9.01.01 Make, type and catalogue number of different electrical items and accessories along with technical leaflets, data sheets etc.

9.01.02 Typical General arrangement drawings showing constructional features, fixing arrangement of pre-fabricated cable trays.

9.01.03 Bill of Materials for cable trays and accessories, conduits & accessories.

9.01.04 Layout of Grounding system and lightning protection system showing connection and other details along with backup design calculations and detailed write up.

9.01.05 Bill of materials for grounding and lightning protection system.

9.01.06 Drawing showing details of equipment grounding.

9.02.00 **To be submitted after Award of Contract**

9.02.01 Make, type and catalogue number of cable termination kits, joints and accessories.

9.02.02 Detail dimensional drawings showing constructional features, grounding, fixing arrangement etc.

9.02.03 Bill of Materials for Pre-fabricated cable tray and accessories, Conduits & accessories.

9.02.04 Dimensional G.A. drawings and data sheets for different equipment and items supplied under this specification.

9.02.05 Layout drawing of Grounding system and Lightning protection system showing connection details along with backup design calculation and detailed write up.

9.02.06 Bill of material for grounding system and lightning protection system.

9.02.07 Drawing showing details of equipment grounding system.

NOTES AND DETAILS FOR CABLING SYSTEM

1.00.00 GENERAL

1.01.00 These notes and details shall be read and construed in conjunction with Specification and the drawings meant for cable tray details and supporting arrangements in Trench, Racks etc., enclosed elsewhere. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The Cabling System installation work shall conform to the requirements of the latest revisions of the following standards/codes

a) Indian Electricity Rules, 1956, with up to date amendment.

b) I.S. Code of Practice

2.00.00 CABLE ROUTING/LAYING

2.01.01 Cables shall generally be laid on ladder type cable trays either in trenches or overhead supported from building steel/structures except in some cases cables may have to be laid underground and for short runs in conduits for protection or crossing.

2.01.02 For interplant connections, the cables may be routed through an overhead cable bridge or cable trenches/tunnels selection being dependent on site constraints. Directly buried cable shall be avoided as far as possible. Owner's prior approval shall be taken for exceptional cases, where buried cables cannot be avoided.

2.01.03 For underground crossing of railways, roads etc. hume pipes shall be used and shall be laid at a depth of minimum 1000 mm such that cables shall not be damaged.

2.01.04 The cable racks in dust prone areas shall be supported from available structure in vertical configuration with suitable cover to avoid deposition of lignite dust as far as practicable.

2.01.05 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. Power cables shall be on top trays and Control/Instrumentation cables on bottom trays, and it is recommended that trays for cables of different voltage levels be stacked in descending order with higher voltage level above.

2.01.06 Cables for redundant equipment/system shall be run in separate trays in separate route.

2.01.07 Cables from two different services viz. supply from station board and supply from unit board shall be fully segregated to prevent simultaneous damage due to fire in one of the services.

2.01.08 Low level signal cables and other special Instrumentation and Control cables shall run in separate trays. In general, a minimum of 1500 mm clearance shall be maintained between these cables and noise generating equipment (large motors, generators, transformers etc.).

2.01.09 The cable spreaders of each unit shall be compartmentalized by provision of fire proof partition wall.

2.01.10 The floor of the cable spreader rooms shall have to be made water proof so that water does not percolate to lower levels in the event of fire fighting operations. Adequate arrangement for efficient drainage of water shall be provided. The cable raceways should also be suitably curved to avoid water entry through this place.

2.02.00 **Cable Trays/Supports**

2.02.01 Cable trays and covers shall be pre-fabricated type, constructed from minimum 14 SWG sheet steel for trays and 16 SWG for covers and hot-dip galvanized after fabrication.

2.02.02 Cable tray supports shall be cantilever type for each installation. All supports and hardware shall be hot-dip galvanized. Support shall be fixed with bolts and no welding shall be done on the galvanized parts.

2.02.03 Standard cable tray width shall be 600 mm. However, trays with 450, and 300, 150 mm width may be used in some places considering the requirement and space restrictions. For instrumentation and control purpose, some perforated type cable trays of width 150 and/or 100mm may be used particularly in low space area and 600, 450, 300 mm perforated trays may be used depending on site requirement.

2.02.04 Cable trays shall be ladder type with 250 mm rung spacing, 100 mm depth and rung width not less than 50 mm.

2.02.05 All weld for cable tray supports shall have a minimum throat thickness of 6 mm.

2.02.06 Cable trays in areas subjected to excessive lignite dust, or mechanical damage shall have hot-dip galvanised sheet metal tray cover installed on front tray in vertical run and inverted `V' type on upper tray in horizontal run.

Where covers are used on trays containing power cables, consideration should be given to ventilation requirements. Areas where corrosive chemicals are likely to be handled, cable tray and covers shall be epoxy painted.

2.03.00 **Conduits**

2.03.01 Conduits shall be rigid steel coated type; minimum size of conduit shall be limited to 19mm.

2.03.02 Steel conduits with interior coating of silicon epoxy ester for ease of wire pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanized. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS: 9537 Part-II. In chemical handling areas, Battery room etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion.

2.03.03 Conduit runs shall be supported at an interval of 750 mm for vertical run and 1000 mm for horizontal run.

2.03.04 Conduits shall be sized so that conduit fill (ratio of total cable area to conduit area) shall not exceed the following:

One Cable	:	53%
Two Cable	:	31%
Three Cables & Up	:	40%

2.03.05 Conduit runs shall be provided with necessary bends as required.

2.04.00 **Installation**

2.04.01 The Bidder shall install, terminate and connect up all cables and conduits with supporting arrangements as per drawings, cable schedules and interconnection chart/drawings.

2.04.02 The HV power cables of 11 KV/3.3 KV shall be laid in trays or racks as follows:

a) In single layer only.

b) 3 core cables to be laid giving one diameter gap of the largest diameter adjacent cable.

c) Single core cables to be laid in trefoil formation with a spacing equal to diameter of the trefoils.

2.04.03 1100V grade power cables shall be laid in single layer in trays.

2.04.04 1100V grade power cable shall be laid giving one diameter gap of the largest diameter adjacent cable.

2.04.05 Control and Instrumentation cables can be laid up to a maximum of three layers in each tray.

2.04.06 The trays shall be run with a vertical spacing of 300 mm for overhead cable trays as well as inside cable trenches. A minimum of 225 mm clearance shall be provided between the top of tray and beams, cold piping, 500 mm clearance for hot piping/object to facilitate installation of cables in tray.

2.04.07 Adequate pull boxes shall be provided in conduit run to facilitate cable pulling in long runs and also to ensure that there shall be no more than 270 Deg. bends between pull points.

2.04.08 Cable tray/conduit system shall be installed to accommodate cable manufacturer's recommended maximum pulling tension and minimum bending radius.

2.04.09 All openings in the floor and wall for cable access shall be sealed after installation of the cable system with non-inflammable materials, as follows:

i) Fire stop/Penetration seal shall be installed in the cable spreaders and cable raceways.

ii) Similarly in the trenches fire stop/penetration seals shall be provided at suitable interval to avoid spread of fire.

iii) For all H.V., L.V., Relay and Control panels, Control desk, instrumentation panels, battery charger, D.C. Dist. boards and other miscellaneous panels, fire-stops should be provided below base plate.

2.04.10 All floor/wall openings for cable entry to the electrical equipment and accessories shall be sealed with non-inflammable materials, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor/wall unless specified otherwise.

2.04.11 The portion of galvanized steel, which, if required, undergoes any welding at site shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.

2.04.12 The cables shall be coated with fire protection coating as specified elsewhere.

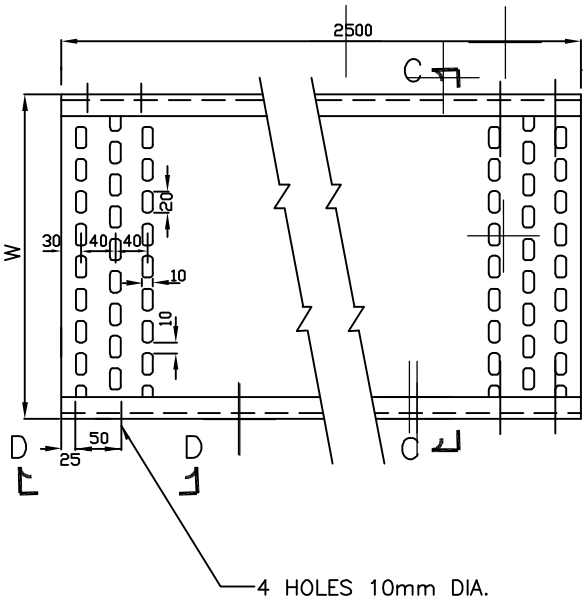
2.05.00 **Identification**

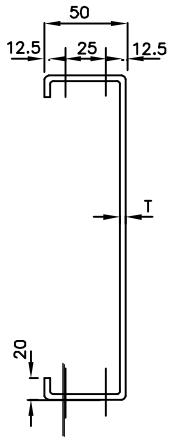
2.05.01 The complete cabling system shall be properly identified. Methods for identification of cabling system shall be furnished to the successful tenderer and the Bidder shall strictly adhere to the said methods.

2.05.02 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

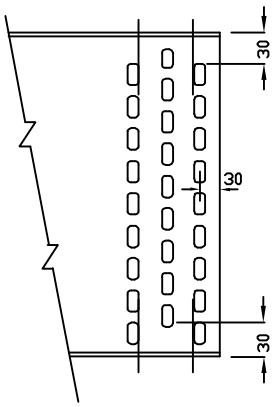
2.05.03 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate, projected above ground level.

2.05.04 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, at each bend and at every thirty (30) metres in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, MCC, control & relay panels etc. wherever required for cable identification, such as where a number of cables enter together through a gland plate.

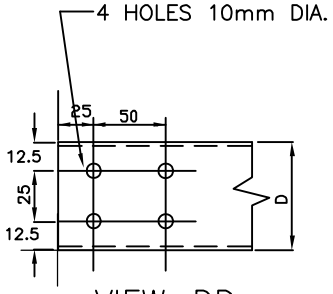




SECTION–CC
(100/50 TRAYS)



ARRANGEMENT OF
PERFORATIONS

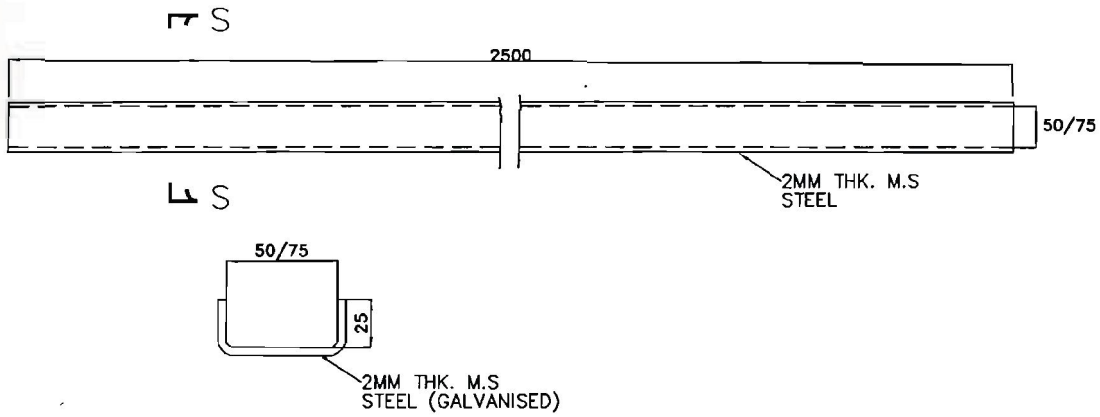


VIEW–DD
(100,50W TRAYS)

TRAY WIDTH W (mm)	100	50
TRAY DEPTH D (mm)	50	50
T (mm)	2	2

PERFORATED TYPE TRAY

भेल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO.



SECTION S–S

CABLE TROUGHS

SEE GENERAL NOTES IN SHEET 11.

	TYPICAL DETAILS OF CABLE TRAY AND ACCESSORIES	BHEL DRAWING NO. PE–DG–427–507–E005
		SH 10 OF 11 | REV 00

TITLE:	SPEC. NO.: **PE-TS-440/441/483-165-N001**
TECHNICAL SPECIFICATION **FRP COOLING TOWER**	SECTION: **I**
	SUB-SECTION: IC
	REV. NO. **0** DATE 27.07.2021
SPECIFIC TECHNICAL REQUIREMENTS	SHEET 1 OF **1**

SUB-SECTION – IC

SPECIFIC TECHNICAL REQUIREMENTS (C & I)

	FGD SYSTEM PACKAGE COMMON SPECIFICATION (For North Karanpura FGD, Bhadadri FGD, Tuticorin FGD projects)	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) FOR FRP-COOLING TOWER SYSTEM	

SPECIFIC TECHNICAL REQUIREMENTS (C&I)

1.0 FRP- Cooling tower system shall be operated from FGD-DCS (DCS-BHEL Scope of supply) through operator work stations.

2.0 All instruments shall be provided with durable epoxy coating for housing and all exposed surfaces of the instruments.

3.0 The following items shall be provided as minimum by bidder corresponding on its offered FRP Cooling tower design (if applicable):

i) Temp Elements with temp transmitters and Temp Gauges for each Gear box.
ii) Redundant level Switch for each of the gear box for lube oil level.
iii) Field junction box for each fan for termination of cables from level switch, temp element with temperature transmitter.

4.0 All integral control system for FRP-Cooling Tower System is in bidder's scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder without any commercial implication.

5.0 The bidder shall provide complete Instrumentation for control, monitoring and operation of entire FRP-Cooling tower. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.

6.0 The make/model of various instruments/items/systems shall be as per customer's approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with, the more stringent requirement as per interpretation of customer/BHEL shall prevail without any commercial implication.

7.0 Power supply derived for contact interrogation, interposing relay and solenoid shall generally be ungrounded 24 V D.C. only.

8.0 The scope of cable shall be referred in Electrical scope split sheet in Electrical portion of the specification.

9.0 Electrical Actuators with integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable, typical Hook−up diagram of drives is included for reference. (as applicable)

10.0 All instruments shall be terminated on JB/LCP in field and both instruments and JB/LCP are in bidder scope. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be subject to customer/BHEL's approval during

detailed engineering.

11.0 Bidder to provide erection hardware including junction boxes, canopies, structural steel as required.

12.0 The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a "No deviation" certificate is to be furnished.

13.0 For instruments which are not located inside covered building, suitable canopy/ protective arrangement shall be provided which shall be approved during detail engineering.

14.0 All the wetted parts of the instruments including the accessories like root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments as well as valves shall be of SS-316 material, suitable pressure class and same shall be in bidder's scope.

15.0 Bidder to provide mandatory spares as per mandatory spares list (refer project specific mandatory spare list). Attached elsewhere in the specification

16.0 Quality plan for instruments/equipment given under North karanpura specification shall be followed in other projects also.

Note: -

1. All equipment items shall be of latest design with proven track record.

2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

	NTPC NORTH KARANPURA STPP (3X660 MW) - FGD SYSTEM PACKAGE	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) FOR FRP-COOLING TOWER SYSTEM	

In addition to the common spec (valid for all three projects)

Specific Technical Requirements (C&I) for North Karanpura:

1.0 All the Electronic Transmitter for Pressure, Temperature and DP based Flow /Level measurements shall be genuine, verifiable PROFIBUS PA protocol compatible instruments. The transmitters shall be connected to DDCMIS through PROFIBUS PA protocol complying to IEC 61158 directly from transmitter. This is subject to customer approval and BHEL decision shall be final.

2.0 The PROFIBUS protocol design shall be further validated by BHEL and approved by NTPC during detailed engineering and any variation/ changes required based on DDCMIS system requirements and actual field installation, operational philosophy etc. shall be considered by bidder without any implications.

3.0 All Temperature sensors shall be Duplex type and temperature transmitter shall be provided for all temperature measurement applications. Bidder to provide temperature transmitter along with compensating cable, JB/Rack & other erection hardware.

4.0 All instruments (except PROFIBUS PA compatible transmitters) and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.

CLAUSE NO.	TECHNICAL REQUIREMENTS

The vibration monitor racks with power supplies shall be mounted in a separate self standing cabinet to be located in control room. The number of racks and power supplies shall be such that on failure of a single power supply/module, not more than four monitors shall be affected. The vibration monitoring cabinet shall be fed from redundant 24V DC feeders with auto changeover scheme.

The power supply arrangement for monitors shall ensure that failure of one power supply shall not affect any monitoring function in the system. Also any power supply failure /earth fault in any of the monitors will be isolated without affecting other monitors/ common power supply. If 230 V AC UPS power supply is required for panel PC/ desktop PC, UPS/Mini UPS for the same shall be provided by the contractor.

The functional requirement for vibration monitoring system shall include but not be limited to the following:

- Vibration monitor front face status indications shall be available for indications of healthy conditions of pick up circuit, monitor circuit and power supply. On sensor fault/wire break in the sensor circuit, the system shall have the feature of identifying the same through suitable means like the signal forced to a value less than 4 mA. In case, such a feature is not available then suitable contact shall be provided from the monitor for sensor fault.
- The facility shall be available for online functional checking of monitors.
- All vibration monitoring equipment shall be functionally tested for circuit continuity and output response. All the components & interconnection cables shall be tested to ensure compliance with the specification requirements & all other applicable codes & standards.

In case it is the proven standard practice of a Contractor to provide vibration monitoring PC with TFT LCD monitor, instead of dedicated monitors with the signal conditioning equipment in control equipment room, the same shall also be acceptable. However, all relevant functional requirements detailed above shall be met and the system shall be subject to Employer's approval.

13.00.00 FIELD INSTRUMENTS BASED ON FIELDBUS

The following instruments shall be connected to DDCMIS through fieldbus i.e. FOUNDATION Fieldbus/PROFIBUS PA protocol complying to IEC 61158 directly from transmitter.

13.01.00 Electronic Transmitter for Pressure, Differential Pressure and DP based Flow / Level measurements.

S No.	Features	Essential/Minimum Requirements
1.	Type of Transmitter	FOUNDATION Fieldbus/PROFIBUS PA based output

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	2	Accuracy	± 0.060 % of calibrated range (minimum) for calibrated range greater than 400 mmwc. +0.065% of calibrated range (minimum) for calibrated range greater than 250 kg/cm2. ± 0.10 % of calibrated range (minimum) for calibrated range less than 400 mmwc.
	3.	Stability	0.25 % of calibrated range for 10 years for calibrated range greater than equal to 400 mmwc on standard conditions of manufacturer. 0.2 % of calibrated range for 1 years for calibrated range less than 400 mmwc on standard conditions of manufacturer. 0.15% of calibrated range for 5 years for DPT with static pressure greater than 250 kg/cm2.
	4	Turn down	50:1 for greater than or equal to span of 400mmwcl. 20:1 for span below 400mmwcl. 10:1 for span greater than 250 kg/cm2
	(Above mentioned (2,3,4) parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only).		
	5	Housing	Weather proof as per IP-67, metallic housing with durable corrosion resistant coating
	6.	Electrical connection	½" NPT(F) FOUNDATION Fieldbus/PROFIBUS PA compatible
	7.	Process connection	½" NPT (F)
	8.	Operating Ambient temperature	85 deg C without display. 70 deg C with display.
		Overpressure	150% of max operating pressure
	9	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & gauge pressure transmitters, -3-valve for DP and 5 valve manifold for level/flow applications. -The valve manifold shall be non-integral type. -For hazardous area, enclosure as described in NEC article 5.

CLAUSE NO.	TECHNICAL REQUIREMENTS

10.	Mounting	2 inch pipe mounting with Enclosure/Rack/Canopy.
11.	Diagnostics & display	Self-Indicating feature and digital display on transmitter

Notes

- For primary air/ secondary air/flue gas/ furnace pressure applications, DP type transmitters shall be provided for pressure measurement below 2000 mmwc.
- LVDT type is not acceptable.
- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

13.02.00 Temperature Transmitter

13.02.01 Single Input /Dual Input Temperature transmitter

Temperature transmitter shall be provided which shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation for thermocouples shall be performed in the temperature transmitter itself. Transmitters shall be capable of withstanding ambient temperature up to 85 deg C.

Following specifications are applicable for dual input/single input temperature transmitter.

S No.	Features	Essential/Minimum Requirements
1.	Output	FOUNDATION fieldbus /PROFIBUS PA
2.	Input	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K, R & ,S types
3.	Housing	Weather proof as per IP-67, metallic housing with durable corrosion resistant coating
4.	Electrical connection	½" NPT(F) FOUNDATION Fieldbus/PROFIBUS PA compatible
5.	Diagnostics & display	Self-Indicating feature and digital display on transmitter
6.	Operating Ambient temperature	85 deg C without display. 70 deg C with display.

CLAUSE NO.	TECHNICAL REQUIREMENTS

3.02.00 Resistance Temperature Detector (RTD)

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well
4	Insulation and sheathing of RTD	:	Mineral (magnesium oxide) insulation and SS316 sheath,
5	Calibration and accuracy	:	As per As per IEC-751/ DIN-43760 Class-A for RTD
6	Accessories	:	Thermo well and associated fittings
7	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for Thermo-well.

NOTES :

1) The specifications for RTDs of winding/ bearings of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be Pt100.

2) The specifications of temp elements for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

3.03.00 Metal Temperature Thermocouples

Measuring Medium	Metal Temperature
Material of Thermocouple.	Chromel Alumel Type K
Type of Thermocouple	Duplex with ungrounded separate hot junctions
Insulation	Mineral Insulation (Magnesium Oxide).

Thermocouple wire gauge	16 AWG
Protective sheath	SS 321
Protective sheath dia	8 mm OD
Calibration & accuracy	As per IEC-584/ ANSI-MC-96.1 (special limits of error) for T/C
Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310. Adjustable gland fitting for connection at the junction box end as per manufacturer's standard.
Cold end sealing	SS pot seal with colour coded PTFE Insulated flexible tails. Sealing compound- Epoxy resin. Length of PTFE insulated flying leads shall be minimum 750 mm.
Minimum bending radius	30 mm
Length of T/C	On as required basis considering location of measurement point and the JB/TTJB location.

Notes :

1) The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However type of thermocouples shall be K-type.

3.04.00 **Thermo well** (for all process temp. elements)

(a) Shall be one piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)

(b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.

(c) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if required based on the specified boiler design parameters).

(d) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

3.05.00 **TEMPERATURE TRANSMITTER (TT)**

Following types of 2-wire (loop powered) temperature transmitter (directly powered from 4-20mA input cards of DDCMIS/PLC) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor.

CLAUSE NO.	TECHNICAL REQUIREMENTS

10.	Mounting	2 inch pipe mounting with Enclosure/Rack/Canopy.
11.	Diagnostics & display	Self-Indicating feature and digital display on transmitter

Notes

- For primary air/ secondary air/flue gas/ furnace pressure applications, DP type transmitters shall be provided for pressure measurement below 2000 mmwc.
- LVDT type is not acceptable.
- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

13.02.00 Temperature Transmitter

13.02.01 Single Input /Dual Input Temperature transmitter

Temperature transmitter shall be provided which shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation for thermocouples shall be performed in the temperature transmitter itself. Transmitters shall be capable of withstanding ambient temperature up to 85 deg C.

Following specifications are applicable for dual input/single input temperature transmitter.

S No.	Features	Essential/Minimum Requirements
1.	Output	FOUNDATION fieldbus /PROFIBUS PA
2.	Input	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K, R & ,S types
3.	Housing	Weather proof as per IP-67, metallic housing with durable corrosion resistant coating
4.	Electrical connection	½" NPT(F) FOUNDATION Fieldbus/PROFIBUS PA compatible
5.	Diagnostics & display	Self-Indicating feature and digital display on transmitter
6.	Operating Ambient temperature	85 deg C without display. 70 deg C with display.

CLAUSE NO.	TECHNICAL REQUIREMENTS

7.	Mounting	2 inch pipe mounting with Canopy.
8.	Accessories	As required by service and operating condition.
9.	Composite Accuracy	(Refer note 2)
		RTD =<0.25% of 0-250 deg C span
		T/C-K type =<0.2% of 0-600 deg C span
		CJC accuracy (for thermocouples) shall be =< 1 deg C

Notes:

1. In case of failure (open or burn-out) of RTD/thermocouple, transmitter shall provide low temperature output.
2. Dual input temperature transmitter shall have bump less changeover facility to second sensor in case first sensor fails. This changeover is to be alarmed.
3. Composite accuracy is to be calculated as summation of all applicable accuracies of temperature transmitter for converting sensor input to output (e.g., basic accuracy, digital accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of temperature elements specified. All such accuracy/ temperature effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures. All temperature transmitters shall be interchangeable (i.e. can be used for either RTD or thermocouple) and composite accuracy shall be met for each type of input as specified above.
3. Above mentioned parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only.
4. Dual input temperature transmitters can also be accepted in place of single input TT.

RTD =<0.25% of 0-250 deg C span

T/C-K type =<0.2% of 0-600 deg C span

CJC accuracy (for thermocouples) shall be =< 1 deg C

Notes ***(Common for a) to d) above):-***

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures. All temperature transmitters are to be interchangeable (i.e. can be used for either RTD or thermocouple) and composite accuracy shall be met for each type of input specified in (i) & (ii).

4.00.0 SPECIFICATIONS FOR PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE.

Sl. No	FEATURES	ESSENTIAL/MINIMUM REQUIREMENTS		
		Pr. Gauge/ DP Gauge/ Draught gauges	Temperature Gauge	Level Gauge
1	Sensing Element	Bourdon for high pressure, Diaphragm/ Bellow for low pr.	Inert gas actuated/ Liquid filled other than mercury	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Material of sensing element	SS 316	SS 316	
3	Material of movement	SS 304	SS 304	
4	Body material	Die-cast aluminium	Die-cast aluminium	Forged carbon steel/304 SS
5	Dial size	150mm	150 mm	Tubular covering entire range

6	End connection	1/2 inch NPT (M)	1/2 inch or 3/4 inch NPT (M).	Process connection as per ASME PTC and drain/vent 15 NB
7	Accuracy	±1% of span	± 1% of span	± 2%
8	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
9	Range selection	Shall cover 125% of max. operating press	Shall cover 125% of max. operating temp	Shall cover max. Operating level.
10	Over range	125% of FSD	125% of FSD	-
11	Housing	Weather and dust proof as per IP-55	Weather and dust proof as per IP-55	CS/304 SS leak proof
12	Zero/span adjustment	Provided	Provided	--
13	Identification	Engraved with service legend or laminated phenolic name plate		
14	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of Steel/SS as per CS/Alloy process Requirement.

Notes:-

*Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

5.00.00 PROCESS ACTUATED SWITCHES

FEATURES	ESSENTIAL / MINIMUM REQUIREMENTS		
	Pressure/ Draft Switches/ DP Switches	Temperature switches	Level switches
Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (5 m minimum, to suit application)	Capacitance types, float type, conductivity type, RF type, Ultrasonic type as per suitability to the application. .
Material	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
Over range/ proof pressure	150% of maximum operating pr.	-	150% of maximum operating pr.
Repeatability	+/- 0.5% of full range		
No. of contacts	2 No.+2NC. SPDT snap action dry contact		
Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS)		
Elect. Connection	Plug in socket.		
Set point adjustment	Provided over full range.		
Dead band adjustment	Adjustable/ fixed as per requirement of application.		
Enclosure	Weather and dust proof as per IP-55, metallic housing.		
Accessories	Siphon, snubber, chemical seal, pulsation dampeners as required by process	Thermo well of 316 SS and packing glands	All mounting accessories
Mounting	Suitable for enclosure/ rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-

Power Supply (wherever required)	As per Contractor's Standard practice.

Notes :-

1) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2) Pressure/ Diff pressure switches for very low press/ DP measurements can have sensor material other than SS316 in case of any technical limitation and the offered product is standard product of the manufacture for very low pressure applications.

3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.

4) The specifications of switches for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

6.00.00 SOLENOID VALVES

Solenoid valves shall fulfill the following requirements: -

a) Type 2/3/4 way SS 316/ forged brass (depending on the application subject to Employer's approval during detailed engg.)

b) Power supply 24V DC.

c) Plug in connector connection.

d) Insulation : Class "H"

7.00.00 Limit switches

e) Limit switches shall be silver plated with high conductivity and non-corrosive type. Contact rating shall be sufficient to meet the requirement of Fire alarm Control System subject to a minimum of 60V, 6VA rating. Protection class shall be IP-55.

the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.

9.04.00 The Bidder shall be responsible for proper grounding of all equipment under this package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests.

9.05.00 The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Contractor.

10.00.00 FIELD MOUNTED LOCAL JUNCTION BOXES

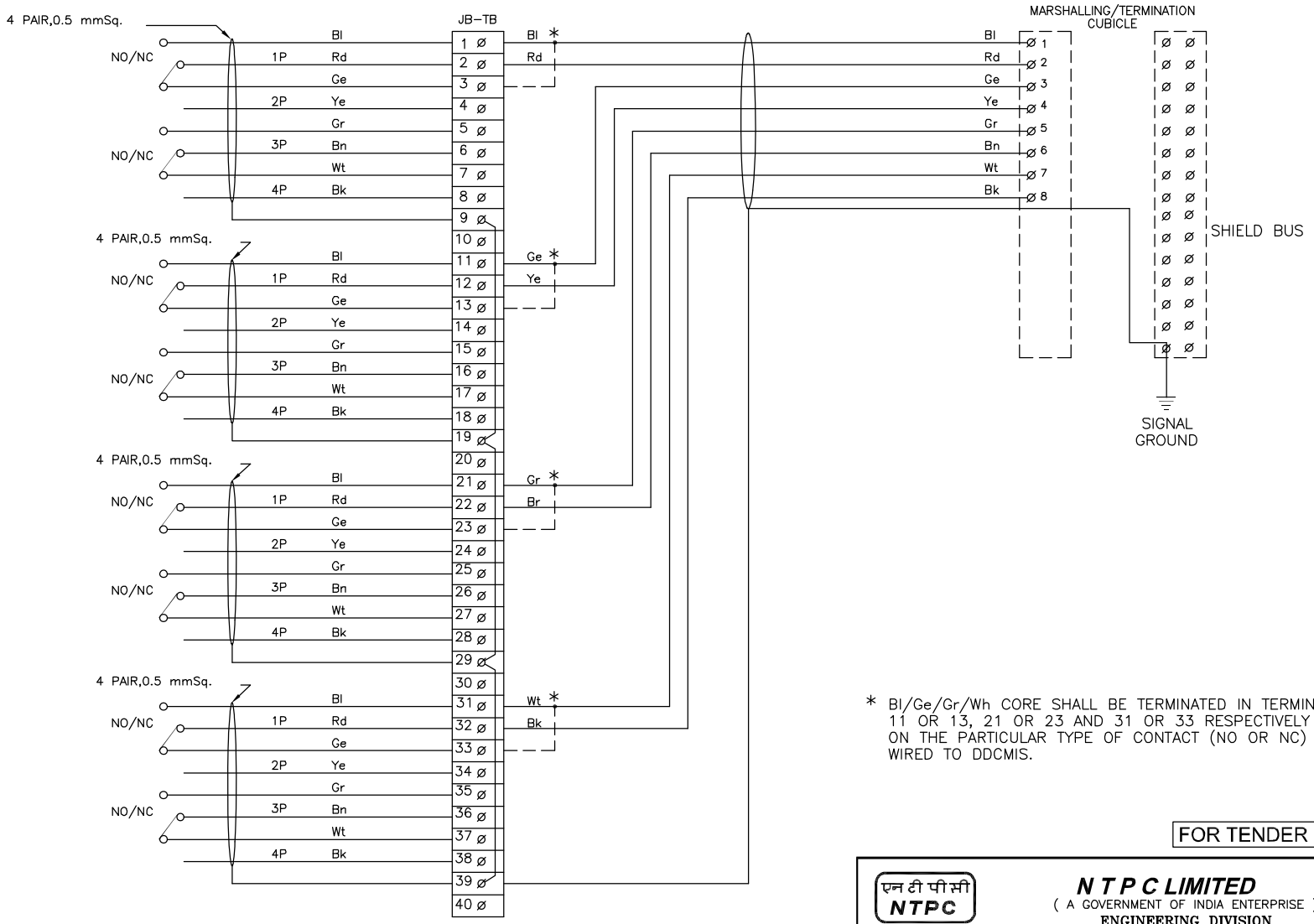
(i)	No. of ways	12/24/36/48/64/72/96/128 with 20% spares terminals.
(ii)	Material and Thickness	4mm thick Fiberglass Reinforced Polyester (FRP).
(iii)	Type	Screwed at all four corners for door. Door gasket shall be of synthetic rubber.
(iv)	Mounting clamps and accessories	Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands required for erection shall be of SS, included in Bidders scope of supply.
(v)	Type of terminal blocks	Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2. A M6 earthing stud shall be provided.
(vi)	Protection Class	IP: 55 minimum for indoor & IP-65 minimum for outdoor applications.
(vii)	Grounding	To be provided.
(viii)	Color	RAL 7035

11.00.00 CONDUITS

11.01.00 Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS: 9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant **terne coated steel** with , water leak, fire and rust proof protected *for the areas of* Mills,Drum, Main Steam, RH steam Air Heaters and Furnace, BFPDT's .

And for remaining applications, water leak, fire and rust proof flexible GI conduits shall be provided. The temperature rating of flexible conduit shall be suitable for actual application.

11.02.00 All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanized steel fitting shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fittings shall be compatible with the flexible conduit supplied.



* Bl/Ge/Gr/Wh CORE SHALL BE TERMINATED IN TERMINAL 1 OR 3, 11 OR 13, 21 OR 23 AND 31 OR 33 RESPECTIVELY DEPENDING ON THE PARTICULAR TYPE OF CONTACT (NO OR NC) IS TO BE WIRED TO DDCMIS.

FOR TENDER PURPOSE ONLY

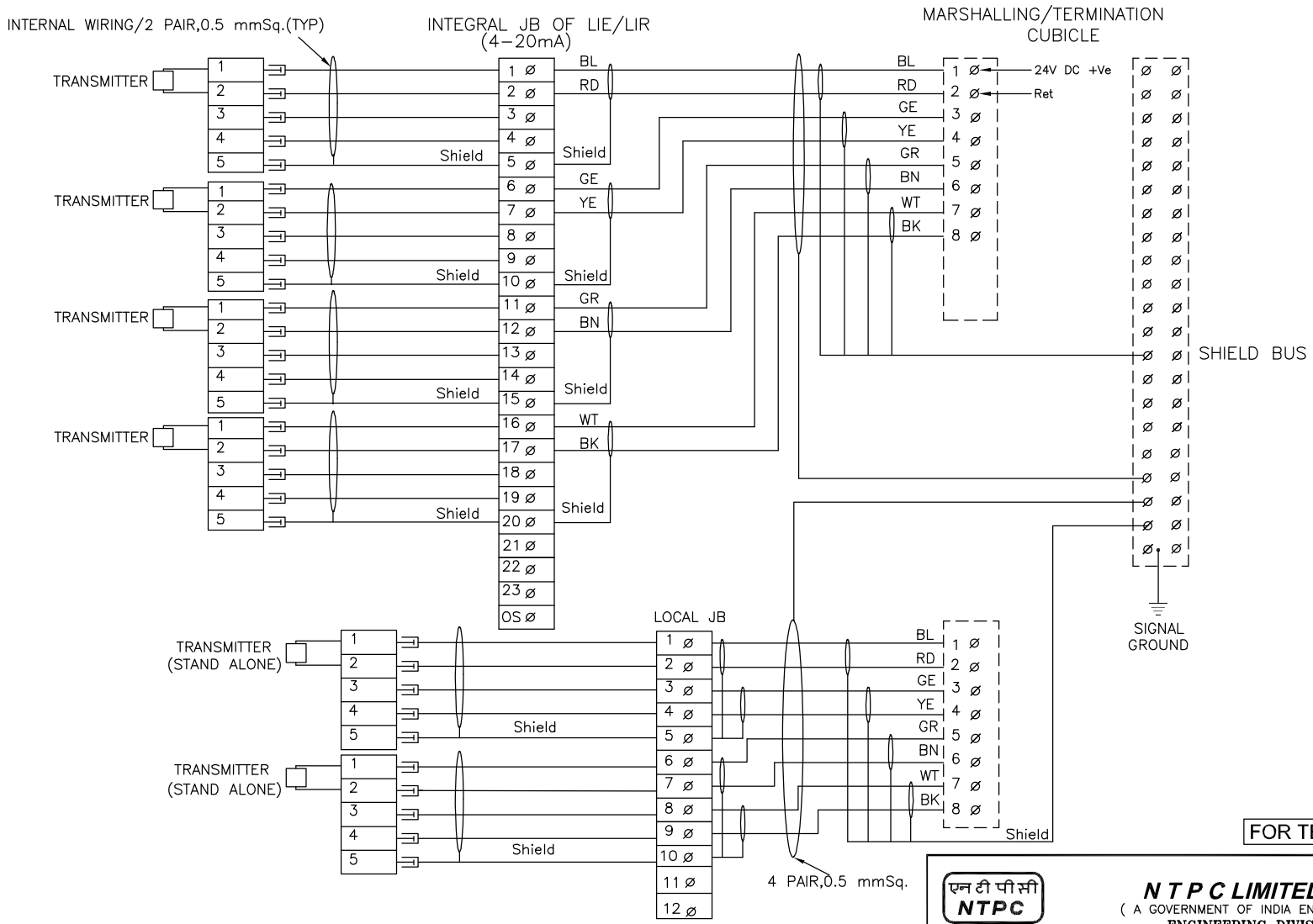
N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
SWITCH TERMINATION DETAILS
NO/NC

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										21.08.12
					CLEARED BY						

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 02 OF 15	A



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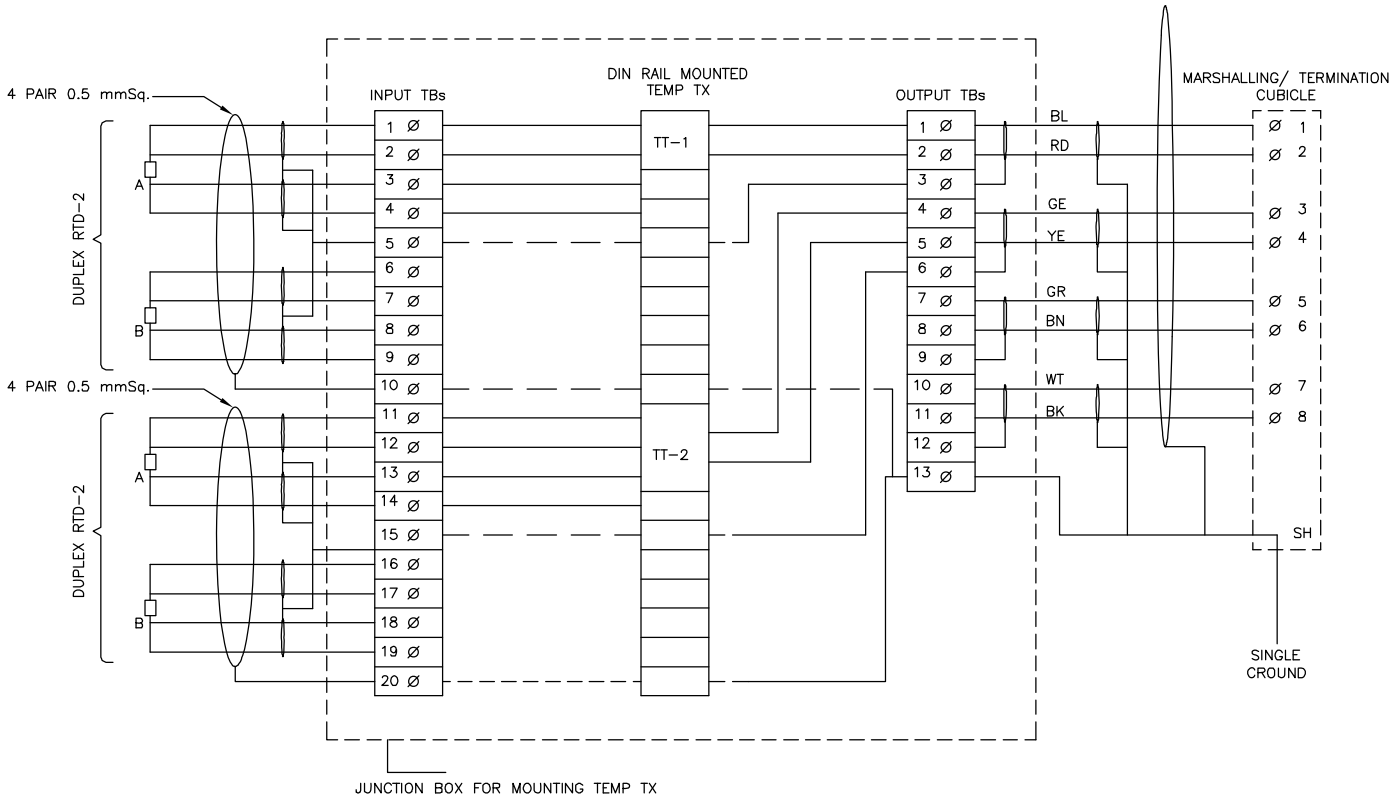
N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
4-20mA

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
B	INTERNAL WIRING FOR LIE/LIR MOUNTED SHOWN WIRING OF STAND ALONE TXTR SHOWN										21.08.12
A	FIRST ISSUE										12.1.05
					CLEARED BY						

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 04 OF 15	B



NOTE :– 1) ABOVE IS THE TYP. DRG. MOUNTED TEMP TRANSMITTER FRO T/C APPLICATION. EXACT TYPE OF TEMP TRANMITTERS SHALL BE AS PER PART–A OF SPECIFICATION.

2) THE EXACT GROUPING OF TEMP TXs SHALL BE FINISHED DURING DERAILED ENGG. STAGE.

3) PLEASE NOTE THAT THIS CONFIGURATION IS SHOWN FOR SINGLE INPUT DIN MOUNTED TT. FOR DUAL INPUT TT BOTH THE ELEMENTS OF RTD SHALL BE CONNECTED TO TT THROUGH INPUT TBs.

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ENGINEERING DIVISION

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										21.08.12
					CLEARED BY						

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
TYPICAL RTD CONNECTION WITH TEMP TRANSMITTERS IN JBs

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 06 OF 15	A

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-60770)	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 (IEC – 754 / 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) 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.

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

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. Analysers	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) 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.

	TUTICORIN FGD (2X500 MW) FGD SYSTEM PACKAGE	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) FOR FRP-COOLING TOWER SYSTEM	

In addition to the common spec (valid for all three projects)

Specific Technical Requirements (C&I) for TUTICORIN

1. All process and valve positioner shall communicate with the DCS in the form of analog signal 4-20 mA DC along with superimposed digital signal through HART protocol.

2. Process switch (Pressure/Level switch) function hall be generally derived from analog process transmitters.

3. Instrument installation and accessories required shall be of SS 316 material or better and shall be in Bidder's scope. All instruments / equipment/fittings shall be IP65 with anti-corrosive coating and suitable for sea water application.

4. Temp transmitter shall be provided for all control applications. Transmitter shall be two wire type and current o/p of 4-20 mA DC with superimposed digital signal in HART protocol. For temp monitoring functions, temp elements (TC/RTD) shall be connected to their respective input module of DCS through instrument cable/Triad cable in case of RTD type element, extension/compensating cable for K type TC.

5. All temp measuring elements (RTD/TC) shall be duplex ungrounded type and both the elements shall be terminated at junction box. Extension/compensating cable for TC and Triad for RTS shall be used for interfacing with DCS. TE shall be supplied with thermowell.

6. Type test for thermocouples, level switches and RTD shall be as per IS-2147 and IEC751 standard.

7. Type test for transmitter shall be as per BS-6447/IEC-770 standard.

VOLUME : II-E

SECTION-III

INSTRUMENTATION AND CONTROL SYSTEM

1.00.00 FIELD INSTRUMENTS

This section provides general guidelines for field instruments, systems and equipment to be supplied under this specification, **as applicable for the Bidder's Scope of Work** for completeness of C&I system. All measuring instruments / equipment and systems / sub-systems offered by Bidder shall be from reputed experienced manufacturer of specified type and range of equipment, whose guaranteed and trouble free operation has been established. All instruments / equipment shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance and comply with the acceptable international standards. All instruments / equipment and accessories shall be supplied as per technical specifications, ranges, make as approved by Owner / Consultant.

All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. and vibration transmitters as required shall be provided. In general, transmitters shall be provided for remote monitoring, alarm, interlock and control. Use of process actuated switches shall be avoided as far as possible unless the same is required as per manufacturer's standard & proven practice.

All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified.

For all instruments envisaged for corrosive liquid applications, they shall be provided with wetted parts made of Monel / Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by Contractor).

All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments. Anti-corrosive paint shall be applied to the field mounted enclosures / instruments.

1.01.00 **Pressure, Differential Pressure, Flow and Level Transmitter**

01.	Working Principle		:	Smart
02.	Type		:	2-Wire
03.	Output signal		:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
04.	Signal Processing Unit		:	Silicon solid-state electronic circuitry
05.	Measuring element		:	Capsule/Diaphragm
06.	Element material		:	AISI-316 (Stainless Steel) or better
07.	Over Pressure		:	150% of maximum pressure
08.	Turn-down ratio		:	10:1 for vacuum / very low pressure application. 30:1 for other application
09.	Span and Zero		:	Continuous non-interacting tamper proof, remote as well as manual adjustable from instrument with zero suppression and elevation facility.
10.	Enclosure		:	Epoxy coated Die cast aluminium. IP-65 (Explosion proof for NEC Class-1, Division 1 area) with ½" NPT (F) cable entry.
11.	Output Indicator		:	LCD type
12.	Body		:	Forged Carbon Steel (SS for DM Water)
13.	Operating Voltage		:	24 V DC ± 10%
14.	Load		:	600 Ohms (min.) at 24 Volts DC
15.	Performance :-			
	a)	Accuracy	:	±0.1 % of span or better
	b)	Repeatability	:	± 0.05 % of span or better
	c)	Response time	:	250 msec or better

	d)	Zero & Span drift	:	0.015% per Deg.C at max span 0.11% per Deg.C at min span
	e)	Stability	:	0.1% of calibrated span for six months for ranges upto and including 70 Kg/ sq.cm. 0.25% of calibrated span for six months for ranges more than 70 Kg/ sq.cm (g).
16.		Process connection	:	½" NPT (F)
17.		Sealing / Isolation	:	Extended diaphragm with 5 meters SS armoured capillary for corrosive, viscous and dirty fluid applications. Material for separator diaphragm, depending on application.
18.		Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.		Accessories	:	a) Installation accessories such as mounting bracket, high tensile carbon steel U-bolts suitable for pipe mounting. b) ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock for pressure transmitter. c) ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock for DP transmitter. 3 valve manifold for DP application in flue gas and air. d) Companion flange with nuts, bolts and gaskets. e) ½" NPT cable gland

1.02.00 **Ultrasonic Level Transmitter**

01.		Principle of operation	:	Detection of reflected ultrasonic pulse

02.	Signal processing	:	Microprocessor Controlled Signal Processing
03.	Type	:	Smart
04.	Display	:	Large alpha-numeric back lit LCD/LED
05.	Calibration & configuration:		Accessible from front of panel
06.	Diagnostic	:	On-line
07.	Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
08.	Construction	:	Plug-on board
09.	Power supply	:	240 V AC 50 Hz / 24V DC
10.	Signal Output	:	4-20 mA DC (isolated) - 600 Ohm load with HART protocol.
11.	Hysteresis	:	Fully adjustable preferred
12.	Output contacts	:	2SPDT Potential free changeover contacts @ 5A 230V AC.
13.	Accuracy & Repeatability	:	0.25% of span or better
14.	Resolution	:	0.1% of span
15.	Operating temp.	:	Transmitter-55 o C and Sensor – 80 o C
16.	MOC Sensor	:	SS 316 in general / PTFE, PP for corrosive application.
17.	Humidity	:	1% to 95% non condensing.
18.	Enclosure	:	IP-65 powder coated die cast aluminium
19.	Cable connection	:	½" NPT with cable gland
20.	Mounting	:	2" flanged for sensor and Transmitter on panel / surface.
21.	Accessories	:	Cable gland, prefab cable, mounting accessories.

Note : Sensors and transmitter shall be separately mounted.

1.03.00 **Radar type Level Measurement**

01.	Type	:	Radar based on Time Domain Reflectometry / Pulse / FMCW as per application	
02.	Antenna	:	Co axial / single rod type guided wave or Horn type as required for the application	
03.	Communication	:	Two wire 4-20mA DC, HART protocol	
04.	Enclosure	:	Explosion proof /IP 65 as per application	
05.	Cable Entry	:	½" NPT	
06.	Calibration	:	a)	Self calibration with internal reference
			b)	Zero & Span calibration
07.	Programming	:	Handheld programmer & Local keypad	
08.	Process Connection	:	Flanged /screwed	
09.	Electronic Housing	:	Epoxy painted Die-Cast aluminium alloy	
10.	Antenna / Flange assembly:		316 SS or Hestalloy (as required)	
11.	Output Indicator	:	Digital Integral Display	
12.	Accuracy	:	5 mm or 0.1% of probe length	
13.	Accessories	:	a)	Programming tool kit, if required
			b)	Gasket

1.04.00 **Pressure Gauge and Differential Pressure Gauge**

01.	Type	:	Bourdon/Bellows/Diaphragm
02.	MOC Sensing & Socket	:	AISI-316 SS
03.	Movement Material	:	AISI-304 SS
04.	Case Material	:	Stainless steel. Enclosure IP-65.
05.	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
06.	Scale	:	Black lettering on white background in 270 Deg. arc.

c) 1/2" NPT 2 Valve SS-316 manifold constructed from bar stock for pressure switch

d) 1/2" NPT 3-Valve SS-316 manifold constructed from bar stock for DP switch

e) ½" NPT cable gland

1.06.00 **Level Switch**

1.06.01 **Type-1**

a)	Type	:	External cage float operated, magnetically coupled
b)	Float material	:	AISI 316 stainless steel
c)	External cage & other wetted part	:	AISI 316 stainless steel
d)	External cage mounting	:	Side Side, on standpipe
e)	External cage connection	:	1" Flanged
f)	Switch housing	:	Epoxy coated die cast aluminum alloy with neoprene gasket conforming to IP-65.
g)	Enclosure class	:	IP 65
h)	Type of switch	:	Snap acting magnetically operated
i)	Switch configuration	:	1DPDT
j)	Contact rating	:	5A, 240VAC / 0.25A, 220V DC
k)	Accessories	:	Counter flange, nuts & bolts, suitable gasket etc. Globe type Drain Valve. ½"NPT cable gland
l)	Application	:	Clean & non acidic fluid application in over ground tanks

1.06.02 **Type-2**

a)	Type	:	Float operated, magnetically coupled

b)	Float material	:	Polypropylene
c)	Housing	:	Polypropylene
d)	Mounting	:	Side mounted.
e)	Process connection	:	1/2" NPT (F) / Flanged
f)	Switch type	:	1 DPDT
g)	Enclosure class	:	IP 65
h)	Contact rating	:	5A, 240VAC/ 0.25A, 220V DC
i)	Cable meters (minimum)	:	Integral FRLS PVC stranded copper (5
j)	Application	:	Acid application in over ground tank

1.06.03 **Type-3**

01	Type	:	Capacitance type
02	Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 1.5 meters. c) Reference rod for non grounded tank.
03.	Probe Mounting	:	1-1/2" Flanged
04.	Material of construction	:	316 SS and to suit fluid type
05.	Insulation	:	PTFE / PP / Kynar Part / Full as required
06.	Enclosure	:	Powder coated Die cast aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Mounting	:	Probe on tap, switch unit separate on surface
08.	Supply voltage	:	240V AC ±10%, 50Hz / 24V DC±10%,
09.	Relay output	:	2 SPDT
10.	Contact rating	:	5A min. at 240V AC on resistive load

	11.	Response time	:	100 msec or better
	12.	Cable connection	:	½" NPT with cable gland
	13.	Accessories	:	Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric. Diagnostic & status LED on front of enclosure.

1.06.04 **Type-4**

	a)	Type	:	Non-contact Ultrasonic type
	b)	Signal processing	:	Microprocessor Controlled
	c)	Display	:	Large alpha-numeric back lit LCD / LED
	d)	Calibration & configuration	:	Accessible from front panel
	e)	Diagnostic	:	On-line
	f)	Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
	g)	Construction	:	Plug-on board
	h)	Power supply	:	240 V AC 50 Hz / 24V DC (UPS supply)
	i)	Hysteresis	:	Fully adjustable
	j)	Output contacts	:	Potential free changeover contacts @ 5A 230V AC.
	k)	Repeatability	:	0.25% of span or better
	l)	Operating temp.	:	Transmitter-55^{o} C and Sensor- 80^{o} C
	m)	MOC Sensor	:	SS 316 in general. PTFE, PP for corrosive application.
	n)	Humidity	:	95% non-condensing.
	o)	Enclosure	:	IP-65 powder coated die cast aluminum
	p)	Cable connection	:	½" NPT with cable gland
	q)	Mounting	:	2" flanged

	r)	Accessories	:	Cable gland, mounting accessories.
	s)	Application	:	Sludge pits and overhead tanks containing slurry, viscous and dirty fluid like slaked lime, lime preparation tank etc.

1.07.00 **Gauge Glass**

01.	Type	:	Reflex or transparent. Resistant to mechanical shocks by steel armour.
02.	Glass	:	Toughened borosilicate
03.	Body material	:	forged Carbon steel / stainless steel as per process requirements
04.	End connection	:	As per ASME PTC and drain /vent valve 15NB
05.	Accuracy	:	± 2%
06.	Pressure rating	:	Twice the maximum working pressure
07.	Scale	:	Linear vertical
08.	Range selection	:	Covers 125% of max. of scale
09.	Test Pressure	:	1.5 times to the max. design pressure at 38°C
10.	Housing	:	CS /304SS
11.	Accessories	:	SS Ball check valves, gaskets, companion flange, SS drain and vent valve, nuts & bolts etc.

1.08.00 **Sight Glass**

01.	Type	:	Flap-type
02.	End connection	:	Screwed / Flanged
03.	Material :		
	a) Body	:	SS-304
	b) Cover Plate	:	SS-304
	c) Indicator	:	SS-316
04.	Sight Glass	:	Toughened Borosilicate

	05.	Gasket	:	Neoprene
	06.	Bolts & Nuts	:	High tensile steel
	07.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
	08.	Accessories	:	As required

1.09.00 **Temperature Gauge**

	01.	Type	:	Bimetallic & all angle tiltable
	02.	Sensing Element Material	:	Bimetal strip helix
	03.	Stem Diameter	:	1/4”
	04.	Stem Material	:	AISI 304
	05.	Thermometer connection to well	:	½” NPT / SS 304
	06.	Case Material	:	Sturdy, corrosion resistant series 304 stainless steel case and bezel.
	07.	Dial Size	:	5” in general
	08.	Scale	:	Anti parallax heavy gauge aluminum with white matte finish glare free. Black lettering on white background.
	09.	Pointer	:	Balanced, lightweight aluminum with matte black finish.
	10.	Dampener	:	Dampening pointer oscillation
	11.	Mounting	:	Surface with adjustable angle.
	12.	Over range Protection	:	150% of range or more
	13.	Dial connection	:	Back connection with stem
	14.	Range	:	Normal temperature – 50 ~ 70% of range approximately.
	15.	Zero adjuster	:	Adjustable screw at back.
	16.	Window	:	Shatterproof glass.
	17.	Accuracy	:	±1 % or better (Grade A / ASME B40.3)

18.	Enclosure Class	:	IP-65		
19.	Accessories	:	a)	Forged/bar stock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M).	
				Material of construction of Thermowell:	
				- SS 316: In general	
				- Inconel: For flue gas application	
				- Tungsten carbide: For lignite mill application.	
				Bidder shall provide Wake frequency calculation for thermowell as per ASME PTC 19.3 (latest edition).	
			b)	Installation accessories as required.	
20.	Nameplate	:	Tag number, service engraved in stainless steel tag plate		

1.10.00 **Thermocouples**

01.	Type	:	a)	Type-K (Chromel-Alumel)	
			b)	Duplex	
			c)	Ungrounded	
02.	Wire gauge	:	16 AWG for Type-K		
03.	Standard	:	ANSI-MC 96.1 for thermocouple		
04.	Protecting Tube :-				
	a) O.D.	:	8 mm		
	b) Material	:	316-SS Seamless		
	c) Filling	:	Magnesium Oxide (Purity above 99.4%)		

05.	Characteristics	:	Linear with respect to temperature within ± ½% of top range value	
06.	Accuracy	:	As per IEC 751 / ANSI MC 96.1 (special class)	
07.	Head	:		
a)	Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)	
b)	Material	:	Epoxy coated Die cast aluminum or better	
c)	Terminal blocks	:	Nickel plated Brass - screw type/ silver plated	
d)	Instrument connection to well	:	½" NPT	
e)	Cable connection	:	½" NPT gland and grommet.	
f)	Others	:	Terminal head cover with SS chain and suitable gasket	
08.	Accessories	:	a)	Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
			b)	Compression fittings/unions
			c)	Flanges etc. (for flanged connections only)
			d)	Forged/bar stock thermowell as per ASME PTC 19.3 code. Process connection M 33X2 (M) in general or 1½" Flanged for Flue gas/ /Air etc. application.
			e)	Material of construction of Thermowell: - SS 316: In general - Inconel: For flue gas application Bidder shall provide Wake frequency calculation for thermowell as per ASME PTC 19.3 (latest edition).

09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

Notes:

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature, at the top of mill or due to lignite burning. Hence the terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

2. Thermocouples provided for steam services like MS temp, HRH, CRH, Turbine metal temp, super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.

1.11.00 **Resistance Temperature Detector**

01.	Type	:	Platinum (Duplex), Ungrounded
02.	Resistance	:	100 ohm at 0 degC
03.	Base	:	Wound on ceramic (anti-inductive)
04.	Wiring	:	3 /4 Wire
05.	Protecting Tube	:	
a)	O.D.	:	8 mm
b)	Material	:	SS-316, Seamless
c)	Filling	:	Magnesium oxide (Purity above 99.4%).
06.	Calibration	:	DIN 43760 Class A
07.	Characteristics	:	Linear with respect to temperature within ± ½% of top range value
08.	Head :		
a)	Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
b)	Material	:	Epoxy coated Die cast aluminum or better
c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated

d)	Cable connection	:	½" NPT gland and grommet.	
e)	Instrument connection to well	:	½" NPT	
f)	Others	:	Terminal head cover with SS chain and suitable gasket	
09.	Accessories	:	a)	Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
			b)	Compression fittings/unions
			c)	Flanges etc. (for flanged connections only)
			d)	Forged/bar stock thermowell as per ASME PTC 19.3 code. Process connection M33X2 (M).
			e)	Material of construction of Thermowell:
				SS 316: In general
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate	

Notes: The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be PT100.

1.12.00 **Field Mounted Temperature Transmitters**

01. Working Principle	:	Smart
02. Type	:	Two wire
03. Input	:	Thermocouple K and RTD (Pt 100)-3/4 wire
04. Isolation	:	500V AC
05. Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
06. Signal Processing Circuitry	:	Microprocessor based Solid State Electronic

07.	Span and Zero	:	Adjustable in field, Non-interacting facility for elevation and suppression of zero.
08.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09.	Output Indicator	:	LCD type
10.	Span Adjustability	:	Yes
11.	Nameplate	:	Tag number to be engraved on metallic tag plate rigidly fixed to the body.
12.	Body	:	Die Cast aluminum
13.	Operating Voltage	:	16-48 V dc
14.	Load	:	600 Ohms at 24V DC (Min.)
15.	Performance		
	a) Accuracy	:	0.4% of span
	b) Repeatability	:	±0.05% of span
	c) Cold Junction Compensation	:	Built-in
	d) Calibration	:	As per N.I.S.T Monograph 125 for T/C and European Curve Alpha = 0.00385 for RTD
16.	Accessories	:	a) Universal mounting bracket suitable for pipe and surface mounting.
			b) Hi-tensile Carbon Steel U-bolts.
			c) ½" NPT cable gland

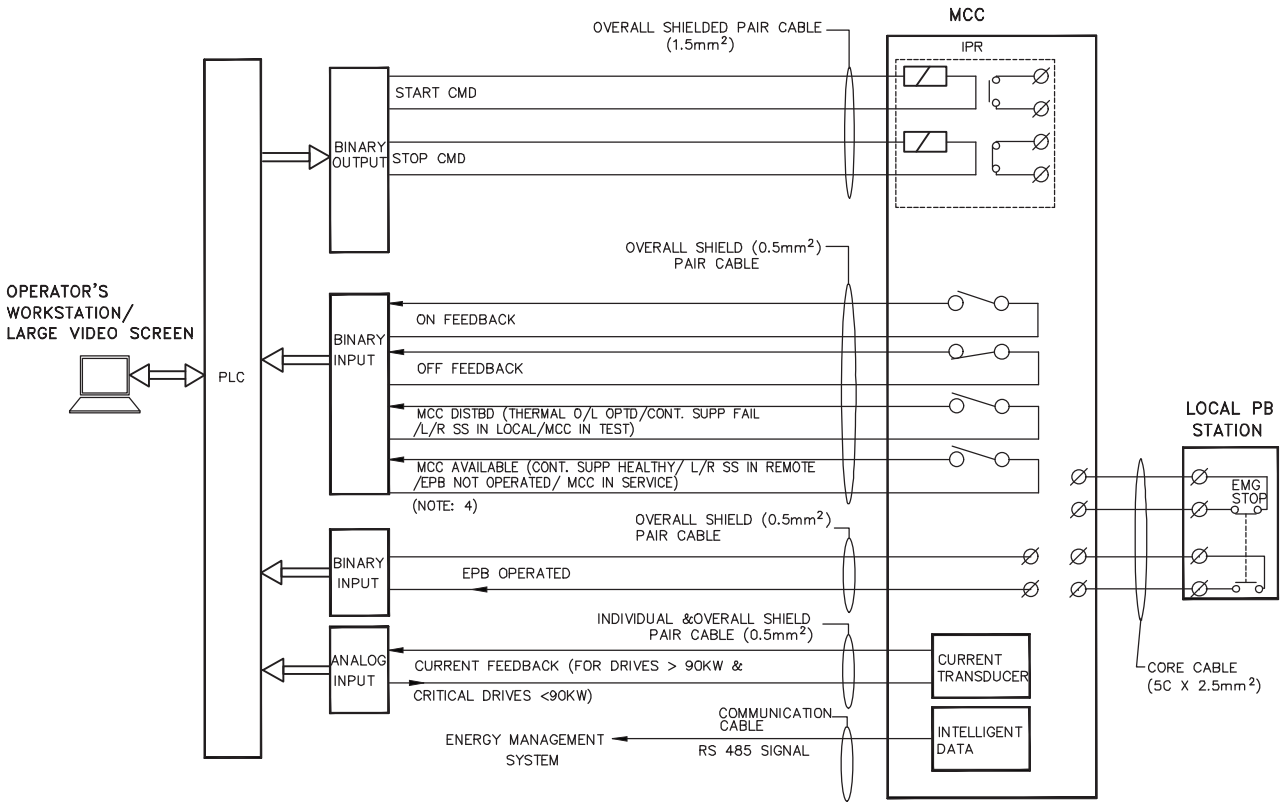
1.13.00 **Temperature Switch**

01.	Type	:	Bimetallic / gas filled-in
02.	Stem /Bulb Material	:	AISI SS-316
03.	Capillary	:	SS Capillary & Flexible armour

04.	Case material	:	Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
05.	Over range Protection	:	120%
06.	Instrument connection	:	Bottom
07.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
08.	Switch configuration	:	One DPDT (Two SPDT)
09.	Switch rating	:	240V, 5A AC/220V, 0.5A DC
10.	Switch type	:	Snap acting, shock and vibration-proof.
11.	Adjustability	:	Internal Set point adjustable over span
12.	Cable connection	:	½" NPT conduit connection or compression gland.
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length. b) Case compensation
14.	Performance :		
	a) Repeatability	:	< 1 % of full range
15.	Capillary length	:	3 meters (minimum)
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	a) Forged thermowell, Mounting accessories, b) ½" NPT cable gland. c) Material of construction of Thermowell: SS 316 : In general Standard : ASME PTC 19.3

1.14.00 Not used.

PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPERATED)



NOTE:

1. IPR – INTERPOSING RELAY
2. PLC VENDOR SHALL FURNISH DETAILED INTERFACE SCHEMES BASED ON THIS BASIC DIAGRAM AND SPECIFICATION.
3. RELEVANT PARTS OF THE SPECIFICATION SHALL BE REFERRED FOR OTHER SPECIFIC REQUIRMENTS (FOR EXAMPLE REDUNDANCY).

FOR TENDER PURPOSE ONLY

REV	DATE	PREPD	CHKD	APPVD	NATURE OF REVISION & DESCRIPTION
0	09.08.2018	AAM	AKP	AT	FIRST ISSUE

REVISION STATUS

OWNER: NLC TAMILNADU POWER LIMITED

PROJECT: 2x500 MW THERMAL POWER PLANT AT TUTICORIN

TITLE: TYPICAL DRIVE INTERFACE

DEVELOPMENT CONSULTANTS PVT LTD.
CONSULTING ENGINEERS
KOLKATA • MUMBAI • CHENNAI • NEW DELHI

PREPARED	AAM	JOB NO.	17A14
CHECKED	AKP	SCALE	NIL
APPROVED	AT	DATE	09.08.2018
DWG. NO.	17A14–DWG–I–0021		REV 0

SHEET 4 OF 8

FILE LOCATION: C:\Users\Administrator\Desktop\AYAN\21-08-2018\17A14-DWG-I-0021-R-0-SHT-4-8.dwg
PLOT DATE: 21 August 2018, 12:07 PM

ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

iii) Conduit supports shall be furnished and installed in accordance with the specifications.

9.01.02 **Junction Box**

01.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
02.	Material	:	3 mm sheet steel/ fiberglass reinforced polyester (UV stabilized)
03.	Type of Cover	:	Solid unhinged with retention chain/ screwed at all four corners
04.	Paint	:	RAL 7032 – Siemens Grey
05.	Mounting	:	Surface/ 2" pipe stanchion (At a dry compartment at one side of the enclosure/ rack with front opening type door)
06.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
07.	Gasket	:	Neoprene
08.	Grounding	:	Brass earth lug with green screw head External-two (2) nos., Internal – one (1) no.
09.	No. of Drain holes	:	Two at bottom capped
10.	Identification	:	Label for JB & tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screw less terminals (suitable for conductor size up to 2.5 sq. mm of suitable voltage grade) with markers and 20% spare terminals. b) Cable gland (Brass) & raceways

9.01.03 **Cable Gland**

01.	Type	:	Double compression

	BHADRADRI FGD (4X270 MW) FGD SYSTEM PACKAGE	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) FOR FRP-COOLING TOWER SYSTEM	

In addition to the common spec (valid for all three projects)

Specific Technical Requirements (C&I) for BHADRADRI

1. Transmitters shall be SMART type and of uniform make. Each SMART equipment shall communicate in the form of analog signal 4-20 mA DC with superimposed digital signal, zero adjustment, calibration and diagnostic from remote location.

2. In general transmitters shall be used instead of switches.

3. Instrument installation and accessories required shall be of SS 316 material or better and shall be in Bidder's scope. All instruments / equipment/fittings shall be IP65 with anti-corrosive coating and suitable for sea water application.

4. Temp transmitter shall be provided for all control applications. Transmitter shall be two wire type and current o/p of 4-20 mA DC with superimposed digital signal in HART protocol. For temp monitoring functions, temp elements (TC/RTD) shall be connected to their respective input module of DCS through instrument cable/Triad cable in case of RTD type element, extension/compensating cable for K type TC.

5. All temp measuring elements (RTD/TC) shall be duplex ungrounded type and both the elements shall be terminated at junction box. Extension/compensating cable for TC and Triad for RTS shall be used for interfacing with DCS. TE shall be supplied with thermowell.

6. Type test for thermocouples, level switches and RTD shall be as per IS-2147 and IEC751 standard.

7. Type test for transmitter shall be as per BS-6447/IEC-770 standard.

c. Siphon for steam and hot water services

d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock

e. Companion flange with nuts, bolts and gaskets

f. ½" NPT cable gland

g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

1.	Type	:	Smart (HART Compatible)
2.	Stages of operation	:	Continuous
3.	Material	:	
4.	i. Displacer		SS-316
5.	ii. Suspension wire		SS-316
6.	iii. Torque tube housing		SS
7.	iv. Torque tube		Inconel
8.	v. Displacer chamber		SS
9.	vi. Transmitter Housing		SS
10.	Operating Voltage	:	24 V DC
11.	Transmission	:	Microprocessor based, 2-wire
12.	Output Signal	:	4-20 mA DC along with superimposed digital signal
13.	Static / overload	:	Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 ^{O}C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2” Flanged
22.	Performance - Accuracy	:	$\pm$ 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½” NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

7.	Turn Down	:	100:1
8.	Accuracy	:	± 0.2 % of measured value
9.	Housing	:	IP 65 (Explosion proof)
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
11.	Accessories	:	a) Handheld calibrator b) Mounting U-bolts, nuts, bolts, prefab cable etc c) ½"NPT cable gland
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Fuel Oil service

1.05.00 RADAR TYPE LEVEL MEASUREMENT

1.	Type	:	Smart (HART Compatible)
2.	Antenna	:	Co axial / guided wave radar /–Overspill protection
3.	Principle	:	TDR (Time Domain Reflectometry)
4.	Communication	:	Two wire 4-20mA DC with HART
5.	Environmental temperature	:	0 – 50 ºC
6.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
7.	Calibration	:	a) Self calibration with internal reference : b) Zero & Span calibration
8.	Process Connection	:	External cage mounting Flanged /screwed
9.	Electronic Housing	:	Epoxy painted Die-Cast aluminium

			alloy
10.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels

1.06.00 ULTRASONIC LEVEL TRANSMITTER

1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1.	Float material	:	SS-316
2.	Wetted parts	:	SS-316
3.	Float chamber	:	Stainless steel/Carbon steel, construction welded
4.	Float chamber mounting	:	Side mounted
5.	Fluid connection	:	Side – Side
6.	Fluid connection size	:	1" ANSI RF Flange (rubber line, if required)
7.	Drain	:	½ inch NPT with Plug
8.	Pressure rating of chamber	:	Minimum 1.5 times of design pressure
9.	Repeatability	:	+/- 1.5 mm or better
10.	Switch housing	:	Stainless Steel
11.	Switch housing type	:	IP- 65
12.	Type of switch	:	Snap acting magnetically operated hermetically sealed
13.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve c) ½"NPT cable gland

			d)	Stainless steel nameplate with alpha-numeric engraved for service and tag
	15. Application	:	During Detail Engineering on Owner's approval	

3.04.00 FLOW SWITCH

1.	Type	:	Paddle /Piston/Disk	
2.	Wetted part material	:	Stainless steel or Hastelloy for acidic application	
3.	End connection	:	a)	Threaded upto 1" line size with integral Tee
		:	b)	Flanged for line size > 1 ½"
4.	Enclosure material	:	Stainless Steel	
5.	Enclosure class	:	IP 65	
6.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)	
7.	Repeatibility	:	2%	
8.	Cable connection	:	½"NPTF	
9.	Accessories	:	a)	Tee, Counter flange, nuts & bolts, suitable gasket etc
			b)	½"NPT cable gland
			c)	Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

1.	Type	:	RADIO FREQUENCY
	Sensing probe		
2.	Material	:	SS-316
3.	Mounting	:	Threaded
4.	Application Temperature	:	250°C (Max.)
	Electronic Controller		
5.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6.	Relay Output	:	2 SPDT (240V AC, 5A)
7.	Ambient Temperature	:	50 °C
8.	Enclosure Protection	:	IP-66
9.	Enclosure Housing	:	SS
10.	Local LED Indication	:	Normal Level Power On Alarm Level Probe Healthy
11.	Switching Repeatability	:	±0.5%
12.	Accessories	:	Co-axial cable for probe connection to controller SS Tag plate ½" NPT Cable Glands
13.	Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1.	Type	:	Conductivity discrimination
2.	Probe MOC	:	SS-316
3.	Mounting	:	Flanged on external cage
4.	Application Temperature	:	250°C (Max.)
5.	Test Pressure	:	Two times rated pressure

	6. Input Supply Voltage	:	240V AC ±10%, 50 Hz.
	7. Input	:	Four independent channel with selectable switching threshold for water conductivity
	8. Relay Output	:	2 SPDT (240V AC, 5A)
	9. Ambient Temperature	:	50 °C
	10. Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
	11. Enclosure Housing	:	SS
	12. Local LED Indication	:	HI,LO, HIGH-HIGH, LOW-LOW Power Fault
	13. Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
	14. Application	:	During Detail Engineering on Owner's approval
3.07.00	TEMPERATURE SWITCH		
	1. Type	:	Bimetallic or gas filled
	2. Sensing Element Material	:	SS-316
	3. Bulb Material	:	SS-316
	4. Capillary	:	Stainless Steel armored

5.	Movement Material	:	Stainless Steel
6.	Case material	:	Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
7..	Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
8.	Over range Protection	:	120 %
9.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
11.	Switch type	:	Snap acting, shock and vibration-proof
12.	Adjustability	:	Internal Set point adjustable over span range
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length b) Case compensation
14.	Performance		
	a) Scale Accuracy	:	±1.0 % of full scale
	b) Repeatability	:	< 0.5 % of full range
	c) Response time	:	Less than 40 seconds with thermowell
15.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	Mounting accessories, ½" NPT cable gland
18.	Applications	:	During Detail Engineering on Owner's

			for corrosive/ viscous/ solid bearing or slurry type fluid applications
		c)	3-Way SS316 Gauge cock for pressure gauges
		d)	5-valve SS316 manifold from barstock for differential pressure gauge
		e)	Siphons for steam and hot water services
	17. Nameplate	:	Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1.	Type	:	Float and Board
2.	Float Material	:	SS-316
3.	Float Cable	:	SS-316
4.	Indicator Assembly	:	Epoxy painted Aluminium
5.	Guide wire spring assembly	:	SS-316 (2 Nos.)
6.	Guide Wire Anchor	:	SS-316
7.	Scale Board	:	Anodized Aluminium with engraved marking (Minimum graduation 10mm), mounting brackets and suitable hardware required as per tank height
8.	Elbow Assembly	:	Anodized Aluminium
9.	Flanges	:	RF , ANSI 150 , SS (3 Nos.)
10.	Accuracy	:	± 10 mm or better
11.	Accessories	:	All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material		
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
4.		:	ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks ii. Drain Valves iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate iv. Illuminating lamps, Mica shield as required v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ^{O} C
9.	Other details	:	For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

4.04.00 SLIGHT GLASS

1.	Type	:	Flap-type.
2.	End connection	:	Screwed / Flanged
3.	Material		
	a) Body	:	SS- 304
	b) Cover plate	:	SS- 304
	c) Indicator	:	SS- 316
4.	Sight Glass	:	Toughened Borosilicate
5.	Gasket	:	Neoprene
6.	Bolts & Nuts	:	High tensile steel.
7.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8.	Accessories	:	Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.

4.05.00 ROTAMETER

1.	Type	:	ON-LINE for line upto and including 50 mm NB. Borosilicate BY-PASS for line size above 50 NB
2.	Metering tube	:	Toughened Borosilicate
3.	Float	:	SS-316
4.	End fittings	:	SS-316
5.	Packing material	:	Teflon / PTFE
6.	Casing	:	Stainless Steel
7.	Gland Rings /Followers/ Other wetted parts	:	Stainless Steel
8.	Orifice Plate	:	Stainless Steel (for bypass type)
9.	Operating Temperature	:	0-50 Deg. c

10.	Test Pressure	:	200% of maximum operating pressure
11.	Scale	:	250 mm nominal length
12.	Graduation	:	Direct reading
13.	Process Connection	:	Flanged (RF) to line size as per ANSI standards (150#)
14.	Tapping	:	D & D/2
15.	Accuracy	:	+/- 2% of full scale reading
16.	Reproducibility	:	Within 0.5% of instantaneous reading
17.	Accessories	:	SS Tag Plate, orifice plate

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

1.	Type	:	Platinum (Duplex), Ungrounded
2.	Platinum (Duplex), Ungrounded	:	100 ohm at 0 ^{O}C
3.	Base	:	Wound on ceramic (anti-inductive)
4.	Wiring	:	3 Wire
5.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
6.	Response time	:	a) 15 sec. (bare).
			b) 30 sec. (with thermowell)
7.	Calibration	:	DIN 43760
8.	Accuracy	:	$\pm$ 0.5%
9.	Head		
	a) Type	:	IP-65 universal screwed type

	b)	Material	:	Stainless Steel
	c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d)	Cable connection	:	½" NPT gland and grommet
	e)	Others	:	Terminal head cover with SS chain and suitable gasket. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
10.	Accessories		:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
11.	Thermowell connection		:	½" NPT (M) or 150 RF Flanged
12.	Nameplate		:	Tag number, service engraved in stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be Pt-100.

5.02.00 THERMOCOUPLES

1.	Type		:	a) 16 SWG wire of Chromel Alumel) (Type-K) b) Duplex c) Ungrounded
2.	Protecting Tube			
	a)	O.D.	:	6 mm
	b)	Material	:	SS-316, Seamless
	c)	Filling	:	Magnesium oxide (Purity above 99.4%).
3.	Response time		:	a) < 20 seconds for measurement b) < 10 seconds for control
4.	Accuracy		:	$\pm$ 1.1^0 C up to 300 ^{0} C & 0.4% of measured temperature range above 300 ^{0}C
5.	Head			
	a)	Type	:	IP-65 universal screwed type
	b)	Material	:	Stainless Steel
	c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d)	Cable connection	:	½" NPT gland and grommet
6.	e)	Others	:	Terminal head cover with SS chain and suitable gasket.

			Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	½" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

			cover conforming to IP 65.
7.	Dial size	:	150 mm
8.	Scale	:	Black lettering on white background in 270 Deg.C arc
9.	Over range protection	:	125 percent of FSD
10.	Capillary Glanding	:	1/2" NPT(M) x compression fitting (SS) to suit capillary
11.	Instrument Connection	:	Bottom connection for local mounting, back connection for panel mounting
12.	Process Connection	:	½" NPT (M) or 150 RF Flanged
13.	Extension Neck Length	:	50 mm
14.	Compensation	:	a) Capillary compensation
15.		:	b) Case compensation
16.	Performance	:	a) Accuracy : + /- 1.0 percent of full scale Deflection
		:	b) Repeatability : Less than 0.5 percent of full range
		:	c) Response time: 15 seconds (max.).
17.	Capillary length	:	3.0 meters (local) / 15.0 metres (local panel)
18.	Other features	:	Shatter proof glass
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
20.	Accessories	:	SS316 Thermowell

5.04.00 THERMOWELL

1.	Material	:	SS-316
2.	Manufacture	:	Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

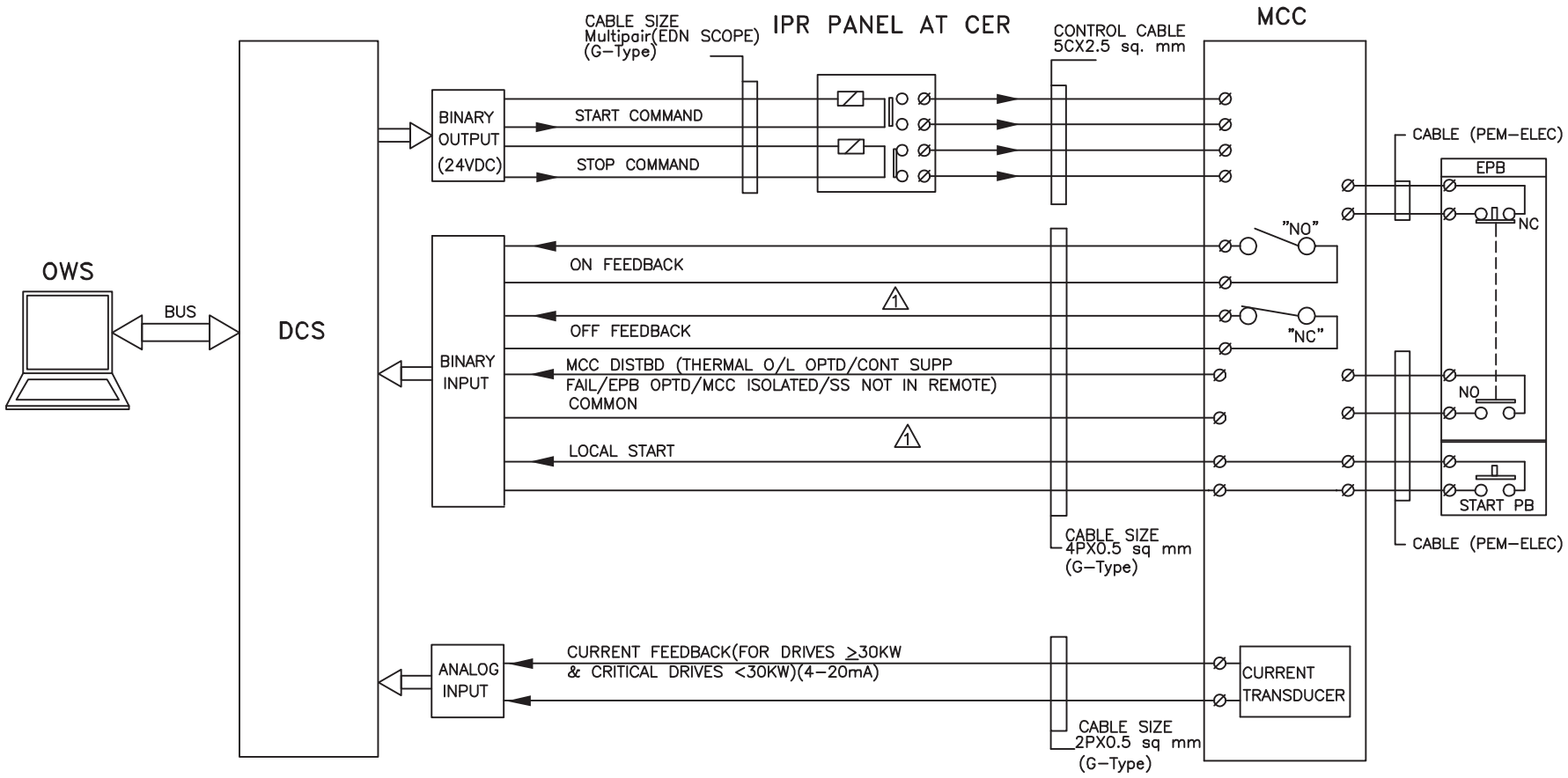
4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2.	Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3.	Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4.	Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

			Surface / Two (2) inch Pipe stanchion
5.	Mounting	:	(At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
7.	Gasket	:	Neoprene
8.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	:	Two at bottom capped
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



* FOR LTUD DRIVES ALL LUBE OIL PUMPS, SCANNER AIR FANS, SEAL AIR FANS, 4-20mA CURRENT TRANSDUCER SHALL BE CONSIDERED.

BHEL Maharatna Company

PROJECT:	1X800 KOTHAGUDEM TPS STAGE-VII, UNIT-12
TITLE:	DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE
DRG.NO.	PE-DM-410-145-I002
DATE	09.03.2015
REV.NO.	01
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SUB-SECTION - IIA

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR FRP CT

STANDARD QUALITY PLAN

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR FRP COOLING TOWERS	STD. SPECIFICATION NO. PE-TS-999-165-N051	
		SECTION : II	
		SUB-SECTION : IIA	
		REV. NO. 0	DATE : 27.07.2021
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1.0 **GENERAL :**

1.1 This standard specification covers the design, manufacture and assembly, inspection and testing at the Vendor's and/or his sub-vendor's works, suitable painting and packing, delivery & assembly at site, erection, commissioning and testing at site of all materials and equipments for mechanical induced draft Cooling tower complete with all accessories as specified hereinafter.

2.0 **CODES AND STANDARD :**

2.1 The design, manufacture, inspection and testing and performance of the Cooling Tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of practice. The latest editions of the following standards and publications shall be followed in particular.

a) Cooling Tower Institution of USA, Bulletin ATC-105 : Acceptance Test Code for Industrial Water Cooling tower.

b) PTC-23:ASME Performance Test Code for Atmospheric Water Cooling equipment.

c) For Electrical, C&I Codes/ Standards refer respective Specification.

d) BS-4485.

2.2 In case of any conflict between the above codes/ standards and this specification, the later shall prevail and in case any further conflict in the matter, the interpretation of the specification by the BHEL Engineer shall be final and binding.

3.0 **DESIGN REQUIREMENTS :**

3.1 The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature as indicated under Data Sheet-A enclosed to this specification.

3.2 All the components shall be capable of safe, proper and continuous operation at all cooling water flows upto and including those specified under Data Sheet-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

3.3 The cooling tower shall be induced draft cross flow/ counter flow type having single or multiple cells. Number of cells in each cooling tower shall be as per enclosed Data Sheet-A.

3.4 The vendor under this specification shall assume full responsibility in proper design and operation of each and every component of the cooling tower as well as the cooling tower as a whole unit.

3.5 The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.

3.6 The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.

3.7 The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification.

4.0 **CONSTRUCTIONAL FEATURES :**

4.1 **Casing and Louvers :**

4.1.1 The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards. Air intake shall be along the base circumference of the casing & metal mesh shall be provided to protect the air intake.

4.1.2 The louvers and casing shall be made of material as specified in the Data Sheet-A.

4.2 **Fill :**

4.2.1 Cooling tower fills type and material shall be as specified in Data Sheet-A.

4.2.2 Design and arrangement of the fills shall be so as to expose high air/ water surface with low air pressure drop.

4.2.3 Fills shall be supported to minimise sag, possibility of dislodgement and damage to fill materials.

4.3 **Drift Eliminators :**

4.3.1 Multipass drift eliminators with minimum two pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A. The drift eliminators shall be of multi-blade rotary type. The drift eliminators can also be of integral type with fills.

4.4 **Hot Water Distribution System :**

4.4.1 Hot water distribution system scope shall be as per Section I of this specification.

4.4.2 The nozzles shall be spaced to give even distribution of water over entire space occupied by top row of fills. The nozzle material shall be as specified in Data Sheet-A

4.4.3 The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Data Sheet-A.

4.5 **Cooling Tower Cold Water Basin :**

4.5.1 Cooling tower basin scope shall be as per Section I of this specification. The cooling tower basin material of construction and basin storage capacity shall be as specified in Data Sheet-A. The basin shall be provided as a part of cooling tower in case of FRP construction. The sump shall have sufficient storage capacity with overflow & drain arrangement for safe operation of plant.

4.6 **Fans & Accessories :**

4.6.1 The fans shall be multiple blade, low speed, high efficiency, axial flow type located for each cell above the top deck level of the cooling tower and the blades shall be individually fastened to the fan hub.

4.6.2 The fan rotating assembly shall be statically balanced.

4.6.3 Each fan blade shall be adjustable as to the degree of pitch and shall be of the material as indicated in Data Sheet-A. It shall be possible to vary blade pitch angle.

4.6.4 Each fan may be driven through a speed reduction unit, specially designed for cooling tower service. The gear reducer shall be heavy duty, industrial design and shall adopt a service factor as specified in data Sheet-A, over fan rated BHP.

4.6.5 The KW rating of the drive motor shall have at least 15% margin over maximum fan power consumption (unless otherwise specified in Data Sheet-A). The design and construction of the drive motor shall be in accordance with the enclosed specification for LV motors.

4.6.6 The materials of fan drive shaft shall be as per Data Sheet-A and shall be specially designed for cooling tower service. Heavy duty flexible coupling with coupling guard shall be provided at shaft ends to compensate for operating misalignment alongwith supporting bearings for the drive shaft.

4.6.7 Each fan shall be provided with an oil level indication and antivibration cut out switch suitably wired and connected as a safety device. Contact rating of the vibration switch shall be furnished for approval of the purchaser. The vibration switch shall be one no per fan. Fan will shut down on high vibration. The noise level of the fan at rated pitch and speed shall not exceed 85 dB at 50 feet.

4.7.0 **Screens in Cold Water Outlet :**

4.7.1 The screens shall be provided as per Data Sheet-A.

4.8 **Hardware :**

4.8.1 All fasteners, nuts and washers etc used in the cooling tower which are coming in direct contact with water or humid air shall be made of stainless steel, all others nuts & bolts etc. shall be made of HDG steel (unless otherwise specified in Data Sheet-A).

4.9 **Access :**

4.9.1 A staircase paddle ladder shall be provided external to the cooling tower at one end of each cooling tower along with stairways, landings, handrails etc. as necessary to give safe and convenient access to the top deck from the ground level. Material of stair case shall be as per Data Sheet-A.

5.0 **INSPECTION AND TESTING :**

5.1 The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.

5.2 Hydrostatic test for the hot water distribution piping (as applicable) shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.

6.0 **PERFORMANCE GUARANTEE TEST AT SITE, TOLERANCE & PENALTIES:**

6.1 The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.

6.2 The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATC 105 Acceptance test for Industrial Cooling Tower.

The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.

6.3 Necessary correction curves required for correcting the test results for any difference in test and guaranteed design condition, shall be furnished by the supplier for approval alongwith the proposed test procedure.

6.4 All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.

6.5 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done in the presence of purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.

6.6 The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature, cooling range, water loading of the tower. The guaranteed power consumption at the design duty of cooling tower shall also be given. If the total power consumption exceeds the guaranteed figure, the vendor shall pay penalty in the following manner.

6.7 No penalty is to be paid if the total power consumption does not exceed the guaranteed figure.

6.8 In case the power consumption measured at the motor input terminals exceeds the guaranteed figure, the vendor will pay to the purchaser liquidated damages as specified in Data Sheet-A.

6.9 The power consumption recorded during performance guarantee test at site shall be considered as actual consumption for computation of penalty as above.

6.10 If any defects are observed, the bidder shall rectify the same without extra cost to the purchaser. Even after rectification if the guaranteed performance is not achieved & performance parameters recorded at site exceeds the acceptable limits of purchaser, the purchaser has right to reject the whole cooling tower and the vendor shall refund the entire money paid to him together with any penalty levied otherwise.

7.0 TENDER EVALUATION :

The offer shall be evaluated as per clause Tender/Bid Evaluation specified in Section I & as stated in NIT.

8.0 SPECIAL CLEANING PROTECTION & PAINTING :

8.1 All equipment shall be neatly finished. All exposed surface shall be smooth and free from burrs/ projections.

8.2 The surface preparation shall be done either mechanically or chemically by one or more of the methods as given in IS-1477 (Part-I)

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8.3 INSIDE SURFACE:

8.3.1 The inside surfaces of the metallic piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with coal tar based epoxy paint of approved make and quality over a coat of Zinc Chromate Primer.

8.4 OUTSIDE SURFACE:

8.4.1 The outside surfaces of the metallic piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with one coat of red oxide primer & coat of synthetic enamel paint of approved shade, make and quality.

8.4.2 Steel parts used for cooling tower construction shall be hot dip galvanised after shop fabrication and shall be coated with rust preventing paints as per approved painting schedule. Before painting galvanized surfaces -etch primer to be applied.

8.5 All parts shall be properly boxed, crated, packed & protected to avoid any damage during transportation and storage at site.

9.0 **DRAWING AND DATA AFTER AWARD OF CONTRACT :**

The vendor shall furnish drawings and other technical documents as given in Data Sheet-C, enclosed with the specification.

10.0 **SPECIAL TOOLS & TACKLES** :

Special tools & tackles, if any, shall be included in scope of supply by the vendor. A list giving description of such tools & tackles shall be furnished by vendor.

11.0 **PACKING :**

All Equipment(s), Material shall be first packed in HDPE/ Bubble wrapping sheets to prevent foreign material (dust, moisture, etc.) entry and then packed in proper sizes wooden cases. High grade woods like Rubber woods, jungle wood, hard wood, mango wood, pine wood, etc. to be used for packing. All the equipment/material shall be protected with suitable packing for entire period in transit and storage against corrosion, incidental damage due to vermin, sunlight, rain, high temperature, humid atmosphere, rough handling.
Small Loose material (such as nuts, bolts etc.) shall be packed in plastic box or plastic bags with proper tagging within Wooden cases.
Special tools and tackles and spares shall be packed separately with adequate identification. Such packages shall be identified as Tools/Commissioning/Operational spares.
Handling Instructions to be marked on outside surface of all Packed Boxes/cases.

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DATASHEET-C

DATA / DOCUMENTS TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

1. General Arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions, limits of scope of supply of piping, limits of civil works, showing extent of platforms, walk ways, handrails, access doors, staircase, etc. and the limits of scope of supply of electrical works and C&I.

2. General Arrangement and Sectional Assembly drawings pertaining to the following components of the Cooling Tower (as applicable):

   a) Tower fill with supporting arrangement.

   b) Drift eliminator installation and details.

   c) Complete hot water distribution system including flow regulating valves, distribution basin/ pipes and nozzles etc.

   d) Arrangement drawing of the cold water outlet piping incorporating also the arrangement of screens, valves and piping terminal details.

3. Technical datasheet as per Datasheet-B format (enclosed in section III).

4. Cooling tower performance curves showing wet bulb temperature V/s. cold water temperature for design cooling range, 90% cooling range and 110% cooling range at 90% ,100% and 110% of design flow.

5. Arrangement drawing of fan assembly drive shaft, fan hub and the gear reducer with materials of construction of different components.

6. Electrical and C&I drawings/documents/datasheets as mentioned in Electrical and C&I Sections/Sub-sections/Section-III of this specification.

7. Load data and calculation on civil works to enable preparation of Civil drawings & civil works by others at site:

   i) Design calculations for strength and suitability showing justification for size of members chosen for all structural components of cooling towers All structural design calculations shall be furnished by the supplier for review/approval of the purchaser.

ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.

iii) Insert details, anchor bolt, foundation bolts details.

iv) Final painting schedule.

v) Other drawings & data as necessary.

8. Cooling tower performance test procedure alongwith details of tests to be conducted for the offered cooling tower.

9. Quality Plan alongwith complete details of the testing and inspection requirements of mechanical, instrumentation and electrical items of the cooling tower in BHEL format.

10. Operation and Maintenance Manuals

11. Field Quality Plan for site activities – viz. Erection & commissioning.

12. Bidder to submit the Hard & soft copy of Approved/As-built drawings for distribution purpose as stated in NIT.

Note:

1) Drawing/document Submission schedule shall be as per NIT.

2) Drawings submitted shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays to bidder's account.

3) Before dispatch of the equipment(s), bidder shall furnish the other documents (viz. Material test certificates, Shop test reports, fulfilment of packing instructions etc.) as stated in NIT.

MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-165-N001	DATE: 26.07.2021
	PROJECT:		PO NO.:	DATE:
	ITEM: FRP-INDUCED DRAFT COOLING TOWER	SYSTEM: ACW SYSTEM	SECTION:	SHEET – OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	C/ N					M	C	N	
1.0	**RAW MATERIAL**													
1.1	RESIN	GEL TIME, CHEMICAL PROP. SOLID CONTENT	MA	LAB TEST	1 PER BATCH		IS 6746	IS 6746	TEST CERTIFICATES	√	P	V		
1.2	GLASS FIBRE CLOTH	WEIGHT/UNIT LENGTH(Avg.)	MA	MEASUREMENT	1 PER BATCH		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST CERTIFICATES	√	P	V		
1.3	GALVANISED ITEM	COATING, ADHESION	MA	LAB TEST	IS 4759		IS 2629/IS 4759	IS 2629/IS 4759	TEST CERTIFICATES	√	P	V		
2.0	**BOUGHT OUT ITEMS**													
2.1	FAN BLADE	DIMENSION	MA	MEASUREMENT	100%		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	INSPN. REPORT	√	P	V		
		SURFACE DEFECTS	MA	VISUAL	100%		ASTM D 2563	ASTM D 2563	INSPN. REPORT	√	P	V		
		MECHANICAL PROPERTIES / CHEMICAL PROPERTIES	MA	LAB TEST	1 PER BATCH		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST CERTIFICATES	√	P	V		
2.2	HUB	DIMENSION	MA	MEASUREMENT	100%		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	INSPN. REPORT	√	P	V		
		SURFACE DEFECTS	MA	VISUAL	100%		ASTM D 2563	ASTM D 2563	INSPN. REPORT	√	P	V		
		MECHANICAL PROPERTIES / CHEMICAL PROPERTIES	MA	LAB TEST	1 PER BATCH		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST CERTIFICATES	√	P	V		

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:			Checked by:		
Reviewed by:			Reviewed by:		

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	Sign & Date	Name	Seal
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Approved by:			

MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-165-N001	DATE: 26.07.2021
	PROJECT:		PO NO.:	DATE:
	ITEM: FRP-INDUCED DRAFT COOLING TOWER	SYSTEM: ACW SYSTEM	SECTION:	SHEET – OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
2.3	NOZZLES	DIMENSIONAL	MA	MEASUREMENT	10% PER LOT		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	INSPN. REPORT	√	P	V		
		WORKMANSHIP & FINISH	MA	VISUAL	10% PER LOT		ASTM D 2563	ASTM D 2563	INSPN. REPORT	√	P	V		
2.4	FILLS, DRIFT ELIMINATOR & LOUVERS	DIMENSIONAL, COLOUR OF FILLS	MA	MEASUREMENT / VISUAL	10% PER LOT		MANUFACTURER'S STD.	MANUFACTURER'S STD.	INSPN. REPORT	√	P	V		
		WORKMANSHIP, FINISH	MA	VISUAL	10% PER LOT		ASTM D 2563	ASTM D 2563	INSPN. REPORT	√	P	V		
2.5	FASTENERS / HARDWARE	CHEMICAL PROPERTIES, MECHANICAL PROPERTIES	MA	CHEMICAL ANALYSIS / LAB TEST	1/LOT		APPD DRAWING / DATASHEET	APPD DRAWING / DATASHEET	TEST CERTIFICATES	√	P	V		
2.6	FASTENERS /HARDWARE	DIMENSION	MA	MEASUREMENT	IS 4759		APPD DRAWING / DATASHEET	APPD DRAWING / DATASHEET	TEST CERTIFICATES	√	P	V		
		WORKMANSHIP	MA	VISUAL	IS 4759		IS 2629/ IS 4759	IS 2629/ IS 4759	TEST CERTIFICATES	√	P	V		
		COATING ADHESION, MASS & UNIFORMITY	MA	LAB TEST	IS 4759		IS 2629	APPROVED DRG/DATASHEET	TEST CERTIFICATES	√	P	V		
2.7	PIPE (GALVANISED)	DIMENSION, WORKMANSHIP & FINISH, MECHANICAL, CHEMICAL & GALV. TEST	MA	VISUAL, DIM, & REVIEW OF TC FOR MECH & CHEM, GALV. CHECK (MASS OF COATING, UNIFORMITY, ADHESION)	IS : 1239 IS : 4759		IS: 1239 IS : 4759	IS: 1239 IS : 4759	TEST CERTIFICATES	√	P	V		

BHEL					
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	PROJECT:		PO NO.:	DATE:
	ITEM: FRP-INDUCED DRAFT COOLING TOWER	SYSTEM: ACW SYSTEM	SECTION:	SHEET – OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	C/ N					M	C	N	
3.0	**IN PROCESS INSPECTION**													
3.1	RESIN MIX	VISCOSITY	MA	VISCOSITY TEST	1 PER BATCH		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	INSPN. REPORT	√	P	V		
3.2	CASING & BASIN CURED FRP COMPONENT	OVERALL DIMENSIONS, THICKNESS	MA	MEASUREMENT	100%		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	INSPN. REPORT	√	P	V		
		WORKMANSHIP & FINISH	MA	VISUAL	100%		ASTM D 2563	ASTM D 2563	INSPN. REPORT	√	P	V		
3.3	HUB MACHINING	DIMENSIONS	MA	MEASUREMENT	100%		MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	INSPN. REPORT	√	P	V		
		WORKMANSHIP & FINISH	MA	VISUAL	100%		ASTM D 2563	ASTM D 2563	INSPN. REPORT	√	P	V		
		SURFACE DEFECT	MA	DP TEST	100%		ASTME 165	NO DEFECTS	INSPN. REPORT	√	P	V		
3.4	FAN ASSEMBLY	STATIC BALANCING, BLADE TIP CLEARANCE, BLADE TRACK VARIATION, OVERALL DIMENSION	CR	STATIC BALANCING. MEASUREMENT	100%		APPD DRG.	APPD DRG.	INSPN. REPORT	√	P	V		
3.5	GEAR BOX	VISUAL, CHEMICAL, MECHANICAL & DIMENSION	MA	MECHANICAL & CHEMICAL PROPERTIES/ MEASUREMENT/ VISUAL	100%		APPD. DWG / DATASHEET	APPD. DWG / DATASHEET	TEST CERTIFICATES	√	P	V		
3.6	GEAR MATCH SET													
3.7	GEAR CASE & COVER	VISUAL DIMENSION, MECHANICAL PROPERTIES / HARDNESS	MA	MECHANICAL & CHEMICAL PROPERTIES/ MEASUREMENT/ VISUAL	100%		APPD DRG /DATASHEET	APPD DRG /DATASHEET	INSPN. REPORT	√	P	V		

BHEL					
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Prepared by:			Checked by:		
Reviewed by:			Reviewed by:		

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Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
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MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-165-N001	DATE: 26.07.2021
	PROJECT:		PO NO.:	DATE:
	ITEM: FRP-INDUCED DRAFT COOLING TOWER	SYSTEM: ACW SYSTEM	SECTION:	SHEET – OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
3.8	FAN SHAFT	VISUAL, DIMENSION, MECHANICAL & CHEMICAL PROPERTIES	MA	MECHANICAL & CHEMICAL PROPERTIES/ MEASUREMENT/ VISUAL	100%		APPD DWG / DATASHEET	APPD DWG / DATASHEET	INSP. REPORT	√	P	V		(UT IS NOT APPLICABLE FOR DIA LESS THAN 50 MM)
		DPT AFTER MACHINING	MA	DP TEST	100%		ASTME-165	NO DEFECT	INSP. REPORT	√	P	V		
3.9	DRIVE SHAFT	VISUAL, DIMENSION, MECHANICAL & CHEMICAL PROPERTIES	MA	MECHANICAL & CHEMICAL PROPERTIES/ MEASUREMENT/ VISUAL	100%		APPD. DWG./ DATASHEET	APPD. DWG./ DATASHEET	INSP. REPORT	√	P	V		
4.0	DRIVE SHAFT ROD/PIPE	DPT FOR DRIVE SHAFT AFTER FINISHING MACHINING	MA	NDT	100%		ASTME-165	NO DEFECTS	INSP. REPORT	√	P	V		(UT IS NOT APPLICABLE FOR ROD/PIPE NB 50 MM AND BELOW)
4.1	DRIVE SHAFT YOKE	VISUAL, DIMENSION, MECHANICAL & CHEMICAL PROPERTIES	MA	MECHANICAL & CHEMICAL PROPERTIES/ MEASUREMENT/ VISUAL	100%		APPD DWG / DATASHEET	APPD DWG / DATASHEET	INSP. REPORT	√	P	V		
4.2	HDG STEEL FABRICATION (MECH. EQUIP, SUPPORTS & STEEL GRILLAGE)	DIMENSION & WORKMANSHIP	MA	VISUAL, MEASUREMENT	100%		APPD DWG / DATASHEET	APPD DWG / DATASHEET	INSP. REPORT	√	P	V		
		WELDING DEFECTS	MA	DP TEST	100%		ASTME-165	NO DEFECT	INSP. REPORT	√	P	V		

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Reviewed by:			Reviewed by:		

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MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-165-N001	DATE: 26.07.2021
	PROJECT:		PO NO.:	DATE:
	ITEM: FRP-INDUCED DRAFT COOLING TOWER	SYSTEM: ACW SYSTEM	SECTION:	SHEET – OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
5.0	FINAL INSPECTION													
5.1	GEAR REDUCER ASSEMBLY (GEAR BOX)	VISUAL & RUN TEST	MA	NOISE, BACK LASH, TORQUE LOAD TEST, OIL LEAKAGE & TEMPERATURE RISE	100%	100%	APPD DWG / DATASHEET	APPD DWG / DATASHEET	INSP. REPORT	√	P	W		1.ONE OF EACH TYPE SHALL BE WITNESSED BY BHEL.
5.2	MOTOR													Refer SQP of Motor
5.3	DRIVE SHAFT ASSEMBLY	VISUAL, DIMENSIONAL & DYNAMIC BALANCING	MA	VISUAL, /MEASUREMENT	100%	100%	APPD DWG / DATASHEET	APPD DWG / DATASHEET	INSP. REPORT	√	P	W		ONE OF EACH TYPE SHALL BE WITNESSED BY BHEL.
5.4	COMPLETE FAN ASSEMBLY	POWER CONSUMED, FAN EFFICIENCY, NOISE & VIBRATION	CR	RUN TEST	100%	1/TYPE/ SIZE	APPD DWG / DATASHEET/ATC-105	APPD DWG / DATASHEET/ATC-105	INSP. REPORT	√	P	W		ONE OF EACH TYPE SHALL BE WITNESSED BY BHEL.
5.5	PACKING	PACKING SOUNDNESS	MA	VISUAL	100%	100%	APPROVED PACKING PROCEDURE/ TECH. SPEC.	APPROVED PACKING PROCEDURE/ TECH. SPEC.	INSP. REPORT	√	P	W		
5.6	REVIEW OF QA DOCUMENTATION						AS PER APPD. QAP			√	P	V		

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Reviewed by:			Reviewed by:		

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		CUSTOMER :		QP NO.: PE-QP-999-165-N001	DATE: 26.07.2021
		PROJECT:		PO NO.:	DATE:
		ITEM: FRP-INDUCED DRAFT COOLING TOWER	SYSTEM: ACW SYSTEM	SECTION:	SHEET – OF 6

NOTES :

(a) IN CASE OF FOREIGN SUPPLIER, ALL TEST CERTIFICATES SHALL BE FURNISHED BY THE SUPPLIER, DULY WITNESSED/VERIFIED BY BHEL's TPIA.

(b) FOLLOWING TO BE NOTED FOR PACKING:

MATERIAL SHALL BE PACKED SUITABLY IN ORDER TO AVOID DAMAGE DURING TRANSIT AND ALSO DURING STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

PHOTOGRAPHS OF THE PACKING JUST BEFORE DISPATCH FOR INFORMATION OF PEM.

(c) THE LATEST REVISIONS/YEAR OF ISSUE OF ALL THE STANDARDS SHALL BE REFERRED.

(d) BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST, IF REQUIRED.

(e) CHEMICAL AND MECHANICAL TESTS ON THE MATERIAL SHALL BE PERFORMED IN NABL ACCREDITED LABORATORIES.

(f) CALIBRATED INSTRUMENTS SHALL BE USED DURING INSPECTION, EXAMINATION AND TESTING.

(g) BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST, IF REQUIRED.

(h) IN ADDITION TO SHOP TESTS, PERFORMANCE TEST OF COMPLETE COOLING TOWER SHALL BE CARRIED OUT AT SITE AND VENDOR SHALL DEMONSTRATE THE GUARANTEED PARAMETERS AT SITE AS SPECIFIED IN THE SPECIFICATION.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **C**: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **N**: CUSTOMER,

P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL; **TPIA:** THIRD PARTY INSPECTION AGENCY

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:			Checked by:		
Reviewed by:			Reviewed by:		

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

TITLE:	SPEC. NO.: **PE-TS-440/441/483-165-N001**
TECHNICAL SPECIFICATION **FRP COOLING TOWER**	SECTION: **II**
	SUB-SECTION: IIB
	REV. NO. **0** DATE 27.07.2021
STANDARD TECHNICAL SPECIFICATION	SHEET 1 OF **1**

SUB-SECTION - IIB

STANDARD TECHNICAL SPECIFICATION (ELECTRICAL)

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

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 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 for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating 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
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

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 with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

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

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)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical 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.

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

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

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

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

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

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

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

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' 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.

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 stated in 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 U 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 BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

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.

MAKE OF LV MOTORS, CABLE LUGS AND CABLE GLANDS

SL NO.	ITEM/SERVICE DESCRIPTI	VENDOR NAME (MAKE)	REMARKS
1	CABLE GLANDS	ALLIED TRADERS & EXPORTERS	
2		ARUP ENGG & FOUNDARY WORKS	
3		BALIGA LIGHTING EQPT.PVT.LTD.	
4		COMMET BRASS PRODUCTS	
5		DOWELLS	
6		ELECTROMAC INDUSTRIES	
7		INCAB	
1	CABLE LUGS	DOWELLS	
2		UNIVERSAL MACHINES LTD.	
1	LV MOTORS (NON FLAME PROOF)	ABB	
2		BHARAT BIJLEE LTD.	
3		CROMPTON GREAVES	
4		GE-POWER	
5		KIRLOSKAR ELECTRIC CO LTD.	
6		LAXMI HYDRAULICS PVT. LTD	APPROVED UPTO 200KW
7		MARATHON	
8		NGEF	
9		RAJINDRA ELECT INDUSTRIES	
10		SIEMENS	

Note: Makes of sub-vendor and equipment/components mentioned in the above list are indicative and shall be subject to CUSTOMER/BHEL approval. The bidder may propose name of additional sub-vendors makes based on their experience, which will be subject to CUSTOMER/BHEL approval.

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR, **CR:** CRITICAL
D: DOCUMENTATION

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-		
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-		
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-		HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-		

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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Sign & Date	
Seal	

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✔	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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Sign & Date	
Seal	

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 3 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 4 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG./ SPECS.	LOG BOOK		P	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
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	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 5 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ ASTM-E165	MANUFACTURER'S STD./ APPROVED DATASHEET.	LOG BOOK	✔	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
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Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	THREE DIPS TO BE GIVEN

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
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	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 7 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		4.DURATION	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
		3.HV	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S DWG.	LOG BOOK		P	-	-	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✔	P	V	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 8 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325/IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325/IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✔	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325/IS-12615/IEC-60034 PART-1/IS: 12802	TC	✔	P	V$	-	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TC	✔	P	V$	-	$ NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✔	P	V$	-	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✔	P	W$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 9 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✔	P	W	-	(#): REFER NOTE-8

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.

4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.

5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.

6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.

7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.

8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.

9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B**: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,

P: PERFORM, **W**: WITNESS, **V**: VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR, **CR**: CRITICAL

D: DOCUMENT

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

ANNEXURE-I : FORMAT OF QUALITY ASSURANCE PROGRAMME

Name of Company/ Successful Bidder	NAME OF CONTRACT PACKAGE			QUALITY PLAN FOR						
	Package No. : _____ Bidderr : _____			QP No. : _____ Date _____ Rev.No.: _____ Date _____						
Sl. No.	Component & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Record	Agency	Remarks

ANNEXURE-II: MANUFACTURING QUALITY PLAN

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN	PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :
		ITEM : SUB-SYSTEM:	QP NO.: REV. NO.: DATE: PAGE: …. OF….

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	L	
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.			11.

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) WILL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** MANUFACTURER/SUB-SUPPLIER
C: SUPPLIER/NOMINATED INSPECTION AGENCY, L: PURCHASER
P: PERFORM **W:** WITNESS AND **V:** VERIFICATION. AS APPROPRIATE,

CHP: PURCHASER WILL IDENTIFIED IN COLUM "N"

DOC. NO.: REV……
CAT…..

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	FOR PURCHASER USE	REVIEWED BY	APPROVED BY	APPROVAL SEAL
SIGNATURE					

SUB-SECTION - IIC

STANDARD TECHNICAL SPECIFICATION (C & I)

(BLANK/NOT USED)

TITLE:	SPEC. NO.: **PE-TS-440/441/483-165-N001**
TECHNICAL SPECIFICATION FRP COOLING TOWER	SECTION: **III**
	SUB-SECTION:
	REV. NO. **0** DATE 27.07.2021
	SHEET 1 OF **1**

SECTION III

DOCUMENTS TO BE SUBMITTED BY BIDDER

ALONG WITH TECHNICAL BID:

- **COMPLIANCE CERTIFICATE (ENCLOSED IN SECTION III)**
- **SCHEDULE OF PERFORMANCE GUARANTEE (FORMAT ATTACHED IN SECTION III)**
- **SCHEDULE OF DEVIATION (FORMAT AS PROVIDED IN NIT)**
- **UNPRICE SCHEDULE INDICATING 'QUOTED' AGAINST LIST OF ITEMS (FORMAT AS PROVIDED IN NIT)**
- **GA DRAWING FOR REFERENCE PURPOSE ONLY.**

AFTER AWARD OF CONTRACT:

- **DATASHEET-B (FORMAT ATTACHED IN SECTION III)**
- **MOTOR DATASHEET-C (FORMAT ATTACHED IN SECTION III)**
- **ELCTRICAL LOAD DATA (FORMAT ATTACHED IN SECTION III)**
- **CABLE SCHEDULE (FORMAT ATTACHED IN SECTION III)**
- **OTHER DRAWINGS/DOCUMENTS AS PER SPECIFICATION / NIT.**

	TECHNICAL SPECIFICATION FOR FRP COOLING TOWER 3x660 MW NTPC NORTH KARANPURA STPP-FGD 4x270 MW TSGENCO BHADRADRI TPP- FGD 2x500 MW NTPL TUTICORIN –TPP- FGD	SPEC. NO.: PE-TS-440/441/483-165-N001
		SECTION: III
		REV. NO. 0 DATE 27.07.2021
		SHEET 1 OF 1

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions with regard to same.

b) There are no other deviations w.r.t. specification other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'.

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc.

d) All drawings etc. submitted along with the offer shall be considered for reference only, same shall be subject to BHEL/ CUSTOMER approval in the event of order.

e) The offered materials shall be either equivalent or superior to those specified in the specification.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The erection & commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself. Prices for special tools & tackles, if any, shall also be included in the base price.

g) All sub vendors shall be subject to BHEL/ CUSTOMER approval in the event of order.

h) The Performance guarantees shall stand valid till at least eighteen (18) months after full load commissioning of CT or as per commercial terms and conditions, whichever is later.

i) The hydrostatic testing of piping shall be carried out as specified i.e. at 1.5 times the design pressure.

j) All CT models offered have been supplied by bidder in the past and are meeting the experience qualifying criteria of BHEL/CONSULTANT/CUSTOMER (viz. offered model is successfully operating in two separate stations for at least one year or as specified in Technical PQR). Any deviation to this criteria shall be suitably highlighted in deviation schedule.

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

TITLE:	SPEC. NO.: **PE-TS-440/441/483-165-N001**
TECHNICAL SPECIFICATION **FRP COOLING TOWER**	SECTION: **III**
	REV. NO. **0** DATE **27.07.2021**
SCHEDULE OF PERFORMANCE GUARANTEE **3x660 MW NTPC NORTH KARANPURA STPP-FGD SYSTEM PKG.**	SHEET **1** OF **1**

1.	Guaranteed Auxiliary Power consumption at inlet to motor terminals of Fan at design capacity & design condition	
1.1	Per Fan Motor :	KW :
1.2	Total for each Cooling tower, for all working cells per tower :	KW :
2.	Guaranteed Cold water temperature at each Cooling tower Outlet at Design capacity & Parameters with the working cells	Deg. C :
3.	ACW Pumping Head (MWC) at design capacity (viz. Static lift from top of basin curb wall up to Centre of Hot water Inlet Pipe Nozzle/Flange of Cooling tower (including all loses).	MWC :

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE				
NAME	**DESIGNATION**	**SIGNATURE**	**DATE**	**COMPANY SEAL**

TITLE:	SPEC. NO.: **PE-TS-440/441/483-165-N001**
TECHNICAL SPECIFICATION **FRP COOLING TOWER**	SECTION: **III**
	REV. NO. **0** DATE **27.07.2021**
SCHEDULE OF PERFORMANCE GUARANTEE **4x270 MW TSGENCO BHADRADRI TPP-** **FGD SYSTEM PKG.**	SHEET **1** OF **1**

1.	Guaranteed Auxiliary Power consumption at inlet to motor terminals of Fan at design capacity & design condition	
1.1	Per Fan Motor :	KW :
1.2	Total for each Cooling tower, for all working cells per tower :	KW :
1.3	Total for 4 numbers Cooling tower for project :	KW :
2.	Guaranteed Cold water temperature at each Cooling tower Outlet at Design capacity & Parameters with the working cells	Deg. C :
3.	ACW Pumping Head (MWC) at design capacity (viz. Static lift from top of basin curb wall up to Centre of Hot water Inlet Pipe Nozzle/Flange of Cooling tower (including all loses)	MWC :

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE				
NAME	**DESIGNATION**	**SIGNATURE**	**DATE**	**COMPANY SEAL**

TITLE:	SPEC. NO.: **PE-TS-440/441/483-165-N001**
TECHNICAL SPECIFICATION **FRP COOLING TOWER**	SECTION: **III**
	REV. NO. **0** DATE **27.07.2021**
SCHEDULE OF PERFORMANCE GUARANTEE **2x500 MW NTPL TUTICORIN –TPP-** **FGD SYSTEM PKG.**	SHEET **1** OF **1**

1.	Guaranteed Auxiliary Power consumption at inlet to motor terminals of Fan at design capacity & design condition	
1.1	Per Fan Motor :	KW :
1.2	Total for each Cooling tower, for all working cells per tower :	KW :
2.	Guaranteed Cold water temperature at each Cooling tower Outlet at Design capacity & Parameters with the working cells	Deg. C :
3.	ACW Pumping Head (MWC) at design capacity (viz. Static lift from top of basin curb wall up to Centre of Hot water Inlet Pipe Nozzle/Flange of Cooling tower (including all loses).	MWC :

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE				
NAME	**DESIGNATION**	**SIGNATURE**	**DATE**	**COMPANY SEAL**

	PROJECT:-	Spec. No.: PE-TS-440/441/483-165-N001
	MECHANICAL INDUCED DRAUGHT FRP COOLING TOWER	Section III Rev. 00 Date :
	Title- DATA SHEET 'B'	Sheet 1 of 5

S.NO	ITEM	UNIT	PARTICULARS
1.0	**GENERAL INFORMATION**		
1.1	Tower manufacturer		
1.2	Tower model		
1.3	Tower type		
1.4	Quantity		
1.5	No. of cells (if applicable)		
1.6	Rated circulating water flow	M^3/hr	
1.7	Design wet bulb temperature (ambient)	°C	
1.8	Design inlet air W.B. temp. (considering recirculation)		
1.9	Design dry bulb temp.	°C	
1.10	Design cooling range	°C	
1.11	Design approach to ambient W.B. temperature	°C	
2.0	**PERFORMANCNE DATA**		
2.1	Evaporation loss (at design)	M^3/hr	
2.2	Maximum drift loss	M^3/hr	
2.3	Required pumping head including all losses measured at normal water level in the basin		
2.4	Cooling water flow (L) (kg/hr M^2 of fill area)	$Kg/hr/M^2$	
2.5	Ratio of water to air weights (L/G)	--	
2.6	Temperature of leaving air i. Dry bulb ii. Wet bulb	 °C °C	
2.7	Dry air flow (G) kg/hr M^2 of fill area	kg/hr M^2	
2.8	Dry air density	$kg/hr/M^3$	
2.9	Wet air density	$kg/hr/M^3$	
2.10	Dry air per fan	kg/hr	

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	PROJECT:-	Spec. No.: PE-TS-440/441/483-165-N001
BHEL	MECHANICAL INDUCED DRAUGHT FRP COOLING TOWER	Section III Rev. 00 Date :
	Title- DATA SHEET 'B'	Sheet 2 of 5

2.11	Total wet air per fan	kg/hr	
2.12	Heat transfer co-efficient	--	
2.13	Total fill volume	M^3	
2.14	Total vertical water fall height	M	
2.15	Gross louvered area	M^2	
3.0	**MATERIALS OF CONSTRUCTION**		
3.1	Casing		
3.2	Louvers		
3.3	Cell partition walls (if applicable)		
3.4	Basin partition walls		
3.5	Fan stack		
3.6	Top deck		
3.7	Ladder		
3.8	Hot water piping		
3.9	Hot water distribution basin		
3.10	Hand rail		
3.11	Supporting structure		
3.12	Structural connectors		
3.13	Bolts, nuts, washers and other hardware		
3.14	Nails, anchor bolts		
3.15	Hot water distribution nozzles and splash plates or rotary sprinkler as applicable.		
3.16	Mechanical equipment support.		

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	PROJECT:-	Spec. No.: PE-TS-440/441/483-165-N001
	MECHANICAL INDUCED DRAUGHT FRP COOLING TOWER	Section III Rev. 00 Date :
	Title- DATA SHEET 'B'	Sheet 3 of 5

4.0	**DIMENSIONS**		
4.1	Tower dimension length x width	M	
4.2	Tower height from basin curb to fan deck	M	
4.3	Overall height including basin	M	
4.4	Louver height and angle with horizontal	M degree	
4.5	Louver support distance	M	
4.6	Longitudinal partition provided?	Yes/No	
5.0	**HOT WATER SUPPLY**		
5.1	Nominal dia	M	
5.2	Center line height above basin curb	M	
5.3	Type of connection	--	
6.0	**TOWER BASIN**		
6.1	Height of basin curb from floor level	M	
6.2	Basin dimension i. Inside LXW ii. Outside LXW	 M M	
6.3	Maximum and minimum and normal water level with	M	
7.0	**FAN STACK**		
7.1	Height	M	
7.2	Elevation of top of fan stack from basin curb	M	
7.3	Diameter	M	
7.4	Exit air velocity at top of stack	M/sec	
7.5	Spacing of supports	Mm	
7.6	Fasteners – Material		
7.7	Type		

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	PROJECT:-	Spec. No.: PE-TS-440/441/483-165-N001
	MECHANICAL INDUCED DRAUGHT FRP COOLING TOWER	Section III Rev. 00 Date :
	Title- DATA SHEET 'B'	Sheet 4 of 5

8.0	**DRIFT ELIMINATORS**		
8.1	No.of passes		
8.2	Cross face area per pass		
8.3	Type		
8.4	Material		
8.5	Type of treatment (if applicable)		
8.6	Fasteners – material		
8.7	Type		
9.0	**FAN**		
9.1	Manufacturer		
9.2	Type		
9.3	Model No.		
9.4	Diameter	M	
9.5	No. of blades	--	
9.6	Blade tip clearance	--	
9.7	Fan speed	RPM	
9.8	Tip speed	M/sec	
9.9	Power consumption per fan	BHP	
9.10	Total static pressure	MMWG	
10.0	**FLOW CONTROL VALVE**		
10.1	Make		
10.2	Type and conformance to code in respect of design/testing		
10.3	Size		
10.4	Number offered		
11.0	**VALVES**		
11.1	Numbers offered		

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	PROJECT:-	Spec. No.: PE-TS-440/441/483-165-N001
	MECHANICAL INDUCED DRAUGHT FRP COOLING TOWER	Section III Rev. 00 Date :
	Title- DATA SHEET 'B'	Sheet 5 of 5

11.2	Nominal size		
11.3	Type (rising/non rising spindle)		
11.4	Name of manufacturer		
11.5	Conforms to I.S		
11.6	Material of construction i. Body ii. Stem iii. Trim		
11.7	Type of connection (whether screwed/flanged etc)		
11.8	Test pressure	Kg/cm^2g	

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

	TITLE	SPECIFICATION NO.
बी एच ई एल	**MOTORS** **DATA SHEET – C** **2x500 MW NLC Tamil Nadu Power Ltd.**	VOLUME II B SECTION D REV NO. 00 DATE 12.07.2021 SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.
बी एच ई एल	**MOTORS** **DATA SHEET – C** **2x500 MW NLC Tamil Nadu Power Ltd.**	VOLUME II B SECTION D REV NO. 00 DATE 12.07.2021 SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR				REV.	
NAME	SIGNATURE	DATE	SEAL		

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

ANNEXURE-II

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

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

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

		PROJECT TITLE	2x500 MW NLC Tamil Nadu Power Ltd.	NAME		DATA FILLED UP ON	
		SYSTEM	WASTE WATER TREATMENT PLANT	SIGN.		DATA ENTERED ON	
		DEPTT. / SECTION	MAUX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

CABLE SCHEDULE FORMAT

ANNEXURE III

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.