

- (c) Hanger support rods of less than 10mm diameter for supporting pipes of 50 NB and smaller and less than 12mm diameter for supporting pipes of 65 mm NB and larger, shall not be used.
- (d) Parts of the hanger or support which move relative to the pipes during operation shall be connected to the pipe attachments in such a manner that they lie entirely outside the pipe thermal insulation.
- (e) Attachment to piping shall be as far as possible by clamps.
- (f) Where axial movement is to be restricted or riser clamps are used, suitable lug stops to prevent pipe movement shall be designed for welding on to pipe.
- (g) Bolted pipe clamps shall have a minimum thickness of 5mm for weather protected locations and 6 mm for locations exposed to weather.
- (h) Beam clamps shall be forged steel equipment with a rod to fix a nut.
- (i) All sliding surface of supports and restrains shall have Teflon lining on one surface coming in contact with stainless steel lining on the other surface.
- (j) All piping hangers and supports shall be designed to carry the weight of the piping fitting, thermal insulation, self weight of the hanger assembly and medium transported or test medium whichever is heavier. In addition all rigid rod hangers and variable spring shall be designed to carry the operation load in hot condition.
- (k) All design and fabrication including loading and allowable stresses shall be in accordance with ANSI B31.1. Note shall be taken of the requirements against earthquake at site. Hangers and supports for systems shall be completely engineered and prefabricated for all piping 50 NB and above. Sufficient random materials shall be furnished for field support of all lines of smaller diameter.
- (l) For pipes of design temperature 1000C and more, bottom supports shall be avoided as far as possible and hanger type supports shall only be used. However, where bottom support cannot be avoided, the same shall be provided with suitable shoes along with balls/rollers/rockers (if movement is more than 50 mm) and SS/Graphite is to be used (if the movement is more than 20 mm) to minimise frictional resistance against thermal movements. The material of shoe as well as the ball/rockers/rollers shall be suitable for the design temperature of the supported pipe and shall be of sufficient hardness so as to permit a reasonably long life keeping its roundness and maintaining a low friction factor. Where a constant load type support is required, the bottom support shall also be of constant load type.
- (m) Provision shall be made for support of piping which may be disconnected during maintenance work.
- (n) Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.
- (o) Double nuts or lock-nuts shall be used on hanger rods and bolts in all cases.
- (p) Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.

- (q) Spring hangers should not be loaded more than 80% of the spring travel range.
- (r) Both constant load and variable spring support/hanger shall be provided with outside indicators for deflection and load. Provision for the site adjustment of load at least $\pm 10\%$ shall be incorporated. Also spring locking arrangement and turnbuckles of load/position adjustment shall be provided for all hangers.
- (s) Constant load type spring support/hangers shall be so selected as to permit, for the specific load, an over-travel of at least 25 mm or 20% (whichever is greater) of the specified range of vertical travel. The initial setting of the hangers/supports shall be such that half of the "over-travel" is allowed in either direction. Constant support hangers shall have a support variation of not more than 6% throughout the total travel range.
- (t) Rigid hangers & restraints shall be judiciously selected, without exceeding the stipulated limits of terminal forces & moments & stress level. Struts shall be considered where compressive load is expected.
- (u) Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves (SV), hanger design shall include provision for shock absorbing devices of approved design.
- (v) Vertical restraints near safety valves shall be preferred for taking SV discharge thrust, provided equipment terminal reactions remains within allowable limit.
- (w) Attempts shall be made to avoid use of shock absorbers, dampers etc as far as possible to take care of occasional loading like seismic effect etc by proper engineering of the piping design and effective use of restraints. However, shock absorbers, VISCO- dampers, wherever felt necessary are to be supplied and erected by the bidder.
- (x) Layout of piping shall be properly designed to avoid excessive vibration by effective use of restraints. However, wherever felt necessary, shock absorbers, VISCO- dampers may be employed.
- (y) Hanger rods (except rigid hangers where both tension and compression may occur) shall be subjected to tensile loading only. At hanger locations where lateral movement is anticipated, suitable linkage and rocking washers shall be provided to permit swing.
- (z) For all hangers, the length of suspension shall be so selected that the hanger rod may never make an angle of more than 40 with vertical due to horizontal pipe movements. If this cannot be avoided by erecting the hanger vertically for cold condition, it shall be suitably off set so that the above requirement is fulfilled in cold as well as hot conditions. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- (aa) Hanger support rods of less than 10 mm diameter for supporting pipes 40 NB and smaller and less than 13 mm diameter for supporting pipes of 50 NB and larger, shall not be used.
- (bb) Supports, guides and anchors shall be so designed that excess heat will not be transmitted to the building steel.
- (cc) Tie rods/struts shall preferably be used for restraints to achieve low friction restraining.

- (dd) The Tie-rods/struts shall have proper arrangement and adequate length, so that, thermal movements in other directions, which are intended to be free are not constrained and there is no appreciable shift in centreline of pipe or the elevation of the supporting point on pipe due to sway. The design shall have provisions for adjusting the length to take up any slack and securely locking in position permanently once adjustment is done.
- (ee) Snubbers & dampers shall be designed to take seismic/dynamic loads, thrust due to safety valve discharge. Effort shall be made to limit its use by judicious placement of rigid hangers.
- (ff) Bottom support spring hangers to be avoided as far as possible.

33.6.25

SPRING HANGERS

Constant load hangers shall generally be used when vertical displacement exceeds 40 mm or where the supporting effort variation of available variable spring exceeds 25%.

Constant load hanger shall be of moment coil spring counter balanced design or cam & spring type. Variable spring hangers shall be of helical spring design. Spring hanger/ assembly shall be constructed such that complete release of piping load is impossible in case of spring miss alignment or failure.

Constant load hangers shall have a minimum field adjustment range of 15% of the load. The total travel for constant speed load hangers shall be design travel plus 20% but in no case shall be difference between total travel and design travel be less than 15 mm. The supporting effort variation throughout the travel range of constant load hangers shall not exceed 6%.

Variable spring hangers shall have supporting effort variation of not more than 25% throughout the total travel range.

All springs shall remain under compression throughout their operating regime and never under tension.

Spring hangers shall have provision of rlocking the hangers in any position of the travel.

Spring hangers shall be adjusted to the cold position before shipment and locked in that position. The cold and hot position shall be clearly marked on the travel indicator scales.

All spring hangers shall be locked before performing the hydro test. The locking shall be removed before the line is placed under operation.

33.6.26

SNUBBERS

Snubbers shall be designed to allow normal movement of pipe due to thermal expansion and shall require minimum maintenance.

Snubbers shall be of hydraulic type of Lisega/ ITT Girnell, Germany or owner approved eqvt.

Axes of anubbers/ restraints shall be parallel to the direction of the expected reaction force in operating condition.

33.6.27 **RESTRAINTS & ANCHORS**

All anchors shall be designed for direct rigid fastening to the structural steel member.

Anchors, guides and restraints shall be capable of withstanding the forces and moments due to thermal expansion and dynamic effects.

33.6.28 **STEAM STRAPS & STRAINERS**

Steam traps shall be of inverted bucket/ thermostatic type with integral or separate Y type strainers.

Traps shall have stainless steel internals.

All Y type strainers shall have stainless steel screen of not more than 20 mesh size. Screen open area shall be at least four (4) times the pipe cross sectional area.

Strainer shall have screwed blow off connection with removable plug.

Y type strainers shall be provided along with each steam trap in case the strainer does not form an integral part of the trap.

33.6.29 **SPECIFICATION FOR THERMAL INSULATION**

Insulation materials, cladding and accessories

(a) The insulating material and cladding material shall be as per the tables of material given in the subsequent clauses.

(b) All insulating materials, accessories and protective covering shall be non-sulphurous, incombustible, low chloride content, chemically rot proof, non-hygroscopic and shall be guaranteed to withstand continuous use and without deterioration the maximum temperature to which they will be subjected under the specification conditions.

(c) The use of insulation of finishing materials containing asbestos in any form is not permitted.

(d) Insulation mattress/section shall be supplied in thickness of 25,40,50 and 75 mm. insulation of higher thickness shall be made up in multiple layer using mattress/slabs of thickness specified above. However; if the required thickness is not achieved, the mattress/slabs in increment of 5mm shall be acceptable. The min. & the innermost layer shall be thickest.

33.6.30 **INSULATION MATERIALS**

(a) Rock/glass insulation mattress shall be of long fibered rock or glass processed into fibrous form bonded with a binder. No kind of slag wool inclusion is acceptable.

(b) Calcium silicate pipe insulation shall be composed principally of hydrous calcium silicate reinforced with mineral fibre. It should be asbestos free.

- (c) All insulation shall conform to the quality requirements laid down below and test certificates on samples from the lot to be supplied shall be furnished to employer for approval.

33.6.31 OTHER ACCESSORIES

The contractor shall also provide other accessories such as ceramic boards. Sealants and washers as required.

33.6.32 INSTALLATION

- (a) All surface to be installed shall be cleaned of all foreign materials such as dirt, grease, rust etc, and shall be dry before the application of insulation.
- (b) Before applying the insulation the contractor shall check that all instrument tappings, clamps, lugs and other connections on the surface to be insulated have been properly installed as per the relevant erection drawing.
- (c) All flanged joints shall be insulated only after the final tightening and testing.
- (d) The insulation shall be applied to all surfaces when they are at ambient temp. ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied so as to avoid breaking/ telescoping due to alternate periods of expansion and contraction
- (e) All cracks voids and depressions shall be filled with finishing cement suitable for the equipment operating temp. so as to form a smooth base for the application of cladding.

33.6.33 INSULATION MATERIALS

	Type#1	Type#2	Type#3	Type#4	Type#5	Type#6
Type	Lightly resin bonded mineral (rock) wool	Lightly resin bonded mineral (rock) wool	Bonded glass wool	Resin bonded mineral (rock) wool performed pipe section	Resin bonded glass mineral wool performed pipe section	Calcium silicate performed block type
Apparent density	120-150 Kg/m ³	100 Kg/m ³	64Kg/m ³	140-150Kg/m ³	60-80 Kg/m ³	20-25 Kg/m ³
Mtl. standards	IS: 8183	IS: 8183	IS: 8183	IS: 9842	IS: 9842	IS: 8154
Applicable service	Piping system & equipment with operating temp. above 400°C	Piping system & equipment with operating temp. in range of 60- 400°C	Piping system & equipment with operating temp. in range of 60- 400°C	Piping system of 350 NB and below with operating temp. in range of 60- 650°C	Piping system of 350 NB and below with operating temp. in range of 60- 400°C	Piping system & equipment with operating temp. in range of 400- 600°C

Testing requirement	As per IS:8183	8183	8183	8183	IS:9842	IS:8154
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33.6.34

CLADDING MATERIAL & ACCESSORIES SHALL BE AS SPECIFIED HERE UNDER:

Sl. No.	Item	Basic specification	Description
1.	cladding	Aluminium ASTM B-209-1060 temper H14 or IS:737 Gr.19000/H2	Thickness of sheathing (a) 18SWG (1.219) for diameter for insulated surface 450mm and above and for flat surfaces. (b) 20 SWG (0.91mm) for diameter of insulated surface 150mm and above upto 450mm. (c) 22 SWG (0.71mm) for diameter of insulated surface 150mm and below.
2.	Binding & lacing wire	Galvanized steel wire to IS: 280 for temp. below 400°C and stainless to IS:6528 for temp above 400°C	20 SAWG for all insulation interface temperature.
3.	Straps & brands	(i) Aluminium where interface temperature are below 400°C (ii) Stainless steel where temperature are above 400°C	Band shall be 20 mm wide & 0.6 mm for securing aluminium sheathing anodized aluminium bends shall be used.
4.	screws	Stainless steel	Self tapping, chese headed
5.	Hexagonal wire mesh	(i) Galvanized wire to IS :280 mesh for interface temperature upto 400°C (ii) Stainless steel wire for temperature above 400°C	Wire mesh netting shall be 10 to 13mm aperture at least 0.56 mm diameter wire

33.6.35

INSTALLATION ON PIPING

- (a) All vertical pipes shall be provided with the suitable insulation supports to prevent collapsing/ crushing of insulation due to its self weight. Support rings shall be provided on all vertical piping with a difference in elevation of 4 meter or above, and there shall not be more than 3 meter straight length between support ring.
- (b) Longitudinal joints of insulation mattresses section of horizontal piping shall be on the bottom or at the sides of the pipe.
- (c) When more than one layer of insulation mattress/section is required on piping the circumferential joints on adjacent layer shall be staggered by atleast 150mm and longitudinal joints shall be fitted on pipe using binding wires.

- (d) The mattress type insulation shall be formed to fit the pipe and applied with the mattress edges drawn together at the longitudinal joints and secured by lacing wire pipe section insulation shall be fitted on pipe using binding wires.
- (e) The mattress type insulation is applied in two or more layers each layer of mattress shall be backed with hexagonal wire mesh. For the first layer of insulation and in case of single layer insulation, hexagonal wire mesh shall be provided on both the surface of the mattress. For pipe sections, the sections shall be held in place by binding wires without any wire mesh.
- (f) The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of insulation. Any gap in the insulation shall be filled with loose mineral wool or finishing cement.
- (g) Insulation mattress/section ends shall be terminated at a sufficient distance from the flanges to facilitate removal of bolts.
- (h) The insulation shall be held in place by fastening over with binding wire for insulation surface with diameter upto and including 550mm and with metal bends for insulation surfaces with diameter over 550mm. the fastening shall be done at intervals of 250mm except where specified otherwise. The ends of the binding wire shall be hooked and embedded in the insulation the straps shall be mechanically starched and fastened with metallic clamping seals of the same materials as the strap.
- (i) Insulation for the application on bends and elbows shall be cut into mitred segments, sufficiently short to form a reasonably smooth internal surface. after the application of insulation material in place, insulating cement shall be applied as required to obtain a smooth surface.
- (j) Weather hoods shall be provided for insulated piping passing through floors/walls.
- (k) All pipe attachments coming on horizontal pipes, included pipes and bends shall be insulated along with pipe such that there will be no insulation applied to hanger rod and the component connecting hanger rod to pipe attachment. All pipe attachments exposed to weather shall be provided with weather proof.
- (l) Upstream of all drain lines and the lines connected to steam traps, shall be insulated upto and including first isolating valve for heat conservation. Rest of such lines such as downstream of the drain valves, traps etc. and other lines such as safety valve discharges, vents, etc. shall be insulated for personal protection.

33.6.36

INSTALLATION ON VALVES AND FITTINGS

- (a) All valves fittings and specialties shall be insulated with the same type and thickness of insulation as specified for the connected piping with the special provision and or exceptions as given below.
- (b) All valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminum sheets of thickness same as the connected pipe cladding. Adjoining pipe insulation shall be believed back to permit removal bolts and nuts or bends. The portion of the valve which can not be covered by box type insulation shall be filled by loose insulating material of packing density at least equal to that of the insulating material of adjoining pipe. The insulation for valve/flanges shall be applied after the finishing has been applied over the connected piping. The cladding shall be applied in such a

manner that the bonnet flange can be exposed easily without disturbing the complete insulation and cladding.

- (c) Expansion joints, metallic or rubber shall not be insulated unless otherwise specifically indicated.

33.6.37

INSULATION ON EQUIPMENT

a	The insulation applied to the equipment shall be reinforced with hexagonal wire mesh. One layer of wire mesh shall be provided on the equipment surface prior to application of insulation.
b	Installation on horizontal cylindrical vessel/tanks (including heaters, deaerator, heat exchanger etc.)
c	All the surface of insulation layer, applied on horizontal cylindrical vessel shall be securely fastened by bands upto vessel/tanks outer diameter of 1500mm and below. Where vessel/tank outer diameter exceeds 1500mm, binding wire passing through insulation clip provided both longitudinally and circumferentially at 500 centers shall be used. Gaps in the insulation shall be filled with insulation mineral wool and finished with finishing cement so as to obtain a smooth surface for the application of cladding. The contractor shall provide a support ribs/lugs on the surface of the vessel/tank as necessary. The contractor shall obtain the approval of the employer and the equipment supplier's field engineering representative before performing any welding on equipment. Any heat treatment equipment as per recommendation of equipment supplier shall be performed by the contractor.
d	Installation on vertical cylindrical vessel/tanks (including flash tanks etc.)
e	All vertical vessels/tanks shall be provided with support rings/ribs with other necessary frame work to take up the weight of the insulation prior to HT. the contractor shall obtain the approval of the employer and the equipment supplier's field engineering representative before performing any welding on equipment. Any heat treatment of vessel/equipment that is required after welding of rings/ribs on the vessel/equipment shall be as per recommendation of equipment supplier and shall be as per recommendation of equipment supplier and shall be performed by the contractor.
f	The mattresses shall be held in position by means of 9 SWG steel wire nails, the nails being 25 mm longer than the thickness of insulation to be applied. After the mattresses have been placed over the nails, the nails shall be bent and embedded in the insulation. Alternative, wire loops may be tack welded at 250mm centers to hold the insulation in place.

33.6.38

INSTALLATION OF CLADDING

- (a) All insulation shall be protected by means of an outer covering of aluminium sheathing. All insulation/cladding joints shall be sealed and made effectively weather and waterproof. All flat surfaces shall be given suitable slope to prevent collection of pools of water on the cladding surface. All sheathing shall be protected internally by the application of two coats of bitumenastic paint.
- (b) All longitudinal joints shall have a minimum overlap of 50mm and shall be located at 45° or more below the horizontal for horizontal equipment joints shall be made with cheese headed self tapping galvanized steel screws at 150mm centers.

- (c) All circumferential joints shall have a minimum overlap of 100mm and shall be held in position by stainless steel or anodized aluminium bands, stretched and clamped.
- (d) Removable box type cladding for valves and flanges shall be fitted on the connected pipe cladding, with bands.
- (e) Aluminium cladding shall not come directly into contact with either the equipment surface or with the supporting arrangement on the equipment surface. To this end, adequate layers of 3 mm thick ceramic board shall be provided between the cladding and any supporting arrangement equipment surface, and fitted with self tapping screws/metal bands, as applicable.
- (f) For bends, fittings etc. the cladding shall be provided in segments as to ensure a smooth finish of the cladding.
- (g) For cladding on vertical pipes/equipment, provision for load take up shall be made at every 2 to 4 meters along pipe/equipment axis.
- (h) All joints shall be sealed with acrylic emulsion weather barrier.
- (i) Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminium cladding with copper, copper alloys, tin, lead, nickel or nickel alloys including monal metal.

33.6.39 TESTING AND GUARANTEE

- (a) All tests, as per the applicable material standards and as specified shall be carried out in accordance with the methods prescribed. Employer shall have the right to witness any or all of the tests conducted by the contractor at the shop or laboratory.
- (b) The contractor shall guarantee that if on actual measurement the specified maximum insulation surface temperatures are exceeded, the contractor shall either replace the insulation with a superior material or provide additional insulation thickness at no extra cost.

33.6.40 SPECIFICATION FOR HYDROSTATIC TEST OF PIPING SYSTEM

- 33.6.40.1 on completion of insulation/erection of the piping systems a hydraulic test in accordance with the requirements of the Indian boiler regulations, shall be performed by the contractor, the procedure adopted for hydraulic test shall have the prior approval of the employer, the detailed schemes and procedure for carrying out hydraulic testing shall be prepared and furnished by the contractor and it shall be discussed and finalized during detailed engineering stage.
- 33.6.40.2 Cutting /welding/edge preparation and re-welding required for blanking, temporary piping connection and /or for replacements by spool pieces including reinstallation of components after hydraulic testing shall be the responsibility of contractor.
- 33.6.40.3 The water for the hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the steam generator and high pressure external piping shall be suitably drained and preserved.
- 33.6.40.4 all the valves, high pressure piping and interconnected pipes connecting the pressure parts, shall be subjected to hydraulic test along with the pressure parts, all blank flanges, removable plugs, temporary valves, piping and fittings, spools other

accessories and services required for carrying out hydraulic testing of piping shall be furnished by the contractor, the the pressurization equipment including water piping from the supply, needed for the above test shall also be furnished b the contractor, any defect noticed during the testing shall be rectified and the unit shall be retested by the contractor.

33.6.40.5 The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting authority as per the provision of the IBR and the project manager.

33.6.41 **SPECIFICATION FOR CHEMICAL CLEANING OF PIPING SYSTEM AND EQUIPMENTS**

33.6.41.1 It is indented to chemically clean the following piping system

- (a) boiler feed piping
- (b) heater drains piping
- (c) main condensate piping
- (d) extraction steam piping
- (e) The following equipment which form a part of the above system shall also be included in the cleaning operation.
 - i. H.P. heater
 - ii. L.P. heater
 - iii. Deaerator
 - iv. Gland steam cooler
 - v. Drain cooler

33.6.41.2 Before including chemicals, all the piping system and equipment listed above shall be water flushed, water flushing will be followed by alkaline cleaning acid cleaning and passivation.

33.6.41.3 How ever the bidder shall submit along with the offer his usual procedure and practices for chemical cleaning of the piping and equipment specified. The bidder shall submit all schematics, write-up, details of chemical to be used etc. and detailed procedures he intends to follow, these schematics and procedures shall be subjected to the approval of the employer.

33.6.42 **PRE-CLEANING PROCEDURE**

Prior to starting any phase of cleaning operation the following procedure shall be ensured.

- (a) Installation of all temporary piping valves, pumps and equipments as required for the flushing and chemical cleaning operations.
- (b) Temporary piping shall be routed at floor level as far as possible and secured in place to prevent movement /vibration beyond applicable limits.
- (c) Installation of the instruments as required to ensure satisfactory monitoring and control of the cleaning process. The contractor shall also determine and arrange location for sampling of the cleaning solution during cleaning.

- (d) Bypassing all regulation/control valves coming in the cleaning circuit or installation of temporary spool pieces.
- (e) Installation of special end covers and temporary suction strainers, for boiler feed pumps and condensate pumps. Pump internals shall not be installed.
- (f) Installation of the plastic seal in the condenser neck to protect the turbine from alkaline fumes.
- (g) Blocking and securing of all spring hangers in the steam lines which may be flooded during the cleaning operation.
- (h) Hand cleaning of the interiors of all vessels which are included in the cleaning operation.

33.6.43

GENERAL CLEANING PROCEDURE

- (a) Seal water lines to pump shall be broken and flushed.
- (b) Where pipe lines terminate in spray headers, these headers shall be inspected after each phase of the cleaning operation and cleaned if necessary.
- (c) All strainers shall be observed closely during the cleaning operation by reading differential pressure gauges, and shall be cleaned when the differential pressure exceeds a predetermined value.
- (d) All high points, vents shall be opened periodically to ensure full system flow.
- (e) Upon completion of each stage of cleaning, the waste products shall be drained and transferred to the waste treatment basins, the contractor shall then supply and add the necessary chemicals to the basin to neutralize all waste solutions and rinses generated by the cleaning process, and arrange for its disposal to an area to be indicated by the employer/engineer.
- (f) Strictest safety precautions shall be exercised at all times during the chemical cleaning and during storage and handling of the chemicals, the contractor shall ensure provision of all protective clothing, apparatus and equipment along with necessary first aid kits as required for handling the chemical and for carrying out the cleaning operation.

33.6.44

SPECIFICATION FOR FLASH TANKS

33.6.44.1

The flash tanks and accessories shall be designed, manufactured and tested in accordance with ASME boiler and pressure vessels (B&PV) codes (latest) and other applicable ANSI standards referenced in the above codes.

33.6.44.2

NUMBER AND SIZING

Flash tank shall be provided into which all recoverable drains from turbine casing extraction lines, valves, strainers, main steam, CRH and HRH line drains, cascaded drains from heaters etc. shall be led. Number of flash tanks shall be as per tender drg. Requirement/details of various flash tanks are given below.

- (a) High pressure HP flash tank for accommodating high pressure (above and including hot reheat design pressure) steam drain and HP heater emergency drains, as included in the tender drawing.
- (b) Low pressure LP flash tank for accommodating low pressure (below hot reheat design pressure) steam drain and LP heater emergency drains, as included in the tender drawing.
- (c) Atmospheric flash tank to accommodate alternate drains of steam lines, feed water safety valve discharge and aux. steam line drains, as indicated in the tender drawing.

33.6.44.3

CONSTRUCTIONAL FEATURES

- (a) Flash tanks shall be vertical cylindrical design and of welded construction with torispherical or hemi spherical heads.
- (b) Drains/hot water inlet nozzles shall be tangential to the vessel periphery. Suitable vortex breaker arrangement shall be made at the liquid outlet to the vessel. In the contractor finds better alternative arrangement, the same can be submitted for the employer acceptance & approval.
- (c) The drain & the vent of the flash tanks shall be adequately sized and lead to the condenser. There shall not be any valve on the drain and vent lines. Loop seal shall be provided on the drain if required.
- (d) A man hole shall be provided on the flash tanks for inspection purpose, it shall be diameter of 500mm minimum. The man hole shall be of davit type and shall be provided with grip.
- (e) The flash tanks shall be located on the ground/mezzanine floor of the power house. Necessary structural supports including anchor bolts shall be provided. Three (3) support lags at 120 degree spacing shall be provided on each flash tank. Necessary lugs for handling by the TG hall EOT crane shall be provided.
- (f) The flash tanks shall be provided with a full length level including gauge glass complete with protective rods. Isolation valves and drains. Temperature indicator and temperature switches shall be provided on the flash tanks.
- (g) The flash tanks shall be provided with access ladders. If required for the access to the instruments, valves, main holes etc.

33.6.45

SCHEDULE OF MATERIAL

Shell and head	ASTM A 285 Gr.C
Wear plate/baffle	ASTM A 285 Gr.C
Nozzle neck	ASTM A 106 Gr.B
Manhole nozzle flange and cover	ASTM A 285 Gr.C
Couplings	ASTM A 105
Bolts and studs	ASTM A 193 Gr.B7
Nuts	ASTM A 194 Gr.2 H
Gaskets	spiral wound SS 316 with graphite

However the material as per ASTM A 516 Gr. B shall be acceptable subject to the relevant codes / standards permitting so for the design parameters of various flash tanks.

33.6.46 **SPECIFICATION FOR METALLIC EXPANSION JOINTS**

33.6.46.1 The expansion joint shall be metallic multi-bellows construction shall be used to reduce the reactions (force and moments) at the connected equipment terminals due to thermal expansion / contraction and/or vibration of connected equipment and piping.

33.6.46.2 the design material, construction, manufacture, inspection testing and performance of the expansion joints shall comply with the currently applicable requirement of EJMA, boiler and pressure vessel code section III, ANSI B-31.1 and all statutes, regulations and safety codes.

33.6.47 **CONSTRUCTION DETAILS**

(a) Bellows

- i. The bellow shall be hydraulically or roll formed from perfect cylinders of single ply, 304 grade stainless steel.
- ii. The number of longitudinal weld seams shall be minimum and there shall be no circumferential weld seam.
- iii. Cold formed stainless steel bellows shall not be heat treated.
- iv. All bellow elements shall be pickled after forming.
- v. Equalizing rings, where required, shall be either from high quality casting or from fabrication metal.
- vi. Flanged expansion joints shall be provided with adequate pipe stubs.
- vii. Butt welded expansion joints shall have adequate length of pipe so that site welding does not impair or reduce the joints efficiency.

(b) sleeves

- i. Expansion joints will be furnished with internal sleeves of the same material as the bellows and installed with sufficient clearance to allow full rated deflection. The sleeves shall be welded on the flow inlet end of the joint only.
- ii. Bellow shall have external sleeves with an arrow indicating the direction of flow on the outside. The external steel covers provided to protect bellows from physical damages, shall be suitable for supporting insulation where necessary and shall be detachable.

(c) Tie bars

- i. Joints shall be shipped at neutral length. They shall be provided with suitable erection and knock-off type temporary tie bars to prevent damage and misalignment during transit and also with permanent tie bars along with necessary nuts, bolts, etc.
- ii. The rod on pressure balanced type expansion joints shall be adequately sized to prevent buckling in vacuum services or services either other external loads.

33.6.48 TYPE TEST OF METALLIC EXPANSION JOINT

Following tests (type tests) shall be carried out for metallic expansion joints as per the procedures given in EJMA.

- (a) Life cycle test
- (b) Meridonal yields-rupture testing
- (c) Squirm testing

33.6.49 for the purpose of carrying out type tests: metallic bellows shall be grouped based on the parameters as give below. The bellows conforming to the same combination of these parameters shall constitute one group. Type test shall be carried out on one or specific above.

- i. Material of bellow: based on material of bellow, bellow shall be categorized in to three category namely carbon steel, stainless steel (Eg. SS304,316,321 etc.) & high alloy steel (Eg. inconal).
- ii. Profile of convolutions: each profile shall be considered as separate category (e.g. U profile, V profile & Lyra profile etc.)
- iii. Dimension of bellows: based on the size, the categories shall be as under:
 - Nominal diameter of metallic expansion joint up to and including 800mm NB.
 - Nominal diameter of metallic expansion joint greater than 800mm NB up to and including 1600mm NB.
 - Each size above 1600mm NB shall be a separate category.
- iv. Design pressure: based on the design pressure, bellows shall be categorized as under:
 - Deign pressure from full vacuum up to 5Kg/sq.cm(g).
 - Design pressure above 5Kg/sq.cm(g) and up to 10Kg/sq.cm(g) with or without vacuum.

33.6.50 NUMBER OF CYCLES

For the life cycle test, the number of test cycles shall be minimum 10,000 cycles.

Other tests for the metallic expansion joint shall be carried out as per the approval QP/QA section. Further, other terms and conditions for type test shall be as specified elsewhere in the specification.

33.6.51 SPECIFICATION FOR SURFACE PREPARATION & PAINTING

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

33.6.52.2 All paints shall be delivered to job site in manufactures sealed containers, each container shall be labeled by the manufacture with the manufacture's name type of paint , batch no. and color.

33.6.52.3 unless specified otherwise paint shall not be applied to surface of insulation, surface of stainless /nickel/copper/brass/monal/aluminum/hastelloy/lead/galvanized steel items, valve stem, pump rod, shaft gauges, bearing and contact surface, lined or clad surfaces.

33.6.52.4 All pipelines shall be colour coded for identification as per the colour-coding scheme indicated in Volume II and which will be furnished to the contractor during detailed engineering.

33.6.53 **SURFACE PREPARTION**

33.6.53.1 All surfaces to be paints shall be thoroughly cleaned of oil, grease and other foreign matter, surfaces shall be free of moisture and contamination from chemicals and solvents.

33.6.53.2 the following surfaces scheme are envisaged here, depending upon requirement any one or a combination of these may be used for surface preparation before application of primer.

SP1	solvent cleaning
SP2	application of rust converter (Ruskil or equivalent grade)
SP3	power tool cleaning
SP4	shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer)
SP4*	shot blast cloning /abrasive blast cleaning to SA 21/2 (near white metal) 35-50 microns
SP5	phosphating
SP6	Emery sheet cleaning/ manual wire brush cleaning.

33.6.54 **APPICATION OF PRIMER /PAINT**

33.6.54.1 The paint /primer manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The dry film thickness (DFT) of primer / paint shall be as specification herein.

33.6.54.2 Surface prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surface

33.6.54.3 Where primer coat has been applied in the shop, the primer coat shall be carefully delaminated, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared, primer coat shall be applied prior to intermediate and finish coats.

33.6.54.4 Steel surface that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be premed and finish painted before the grating is permanently secured.

33.6.54.5 Following are the primer/painting schemes envisaged herein:

- | | | |
|------|---|---|
| PS3 | - | zinc chrome primer (Alkyd base) by brush/Spray to IS104. |
| PS3* | - | zinc chrome primer (Alkyd base) by dip coat. |
| PS4 | - | synthetic Enamel (long oil alkyd) to IS2932. |
| PS5 | - | red oxide zinc phosphate to IS-12744. |
| PS9 | - | aluminum paint to IS 2339. |
| PS9* | - | heat resistant aluminium paint to IS-13183 Gr.-I (for temperature 400 °C – 600 °C) , IS -13183 Gr.-II (for temperature 200°C -400°C) and IS-13183 Gr.-III (for temperature up to 200°C) |
| PS13 | - | rust preventive fluid by spray, dip or brush. |
| PS14 | - | weldable primer-Deoxaluminate or equivalent. |
| PS16 | - | high build Epoxy CDC mastic `15'. |
| PS17 | - | aliphatic acrylic polyurethane CDE134, %V=40.0 (min.) |
| PS18 | - | Epoxy based TiO2 pigmented coat. |
| PS19 | - | Epoxy based zinc phosphate primer (92% zinc in dry film (min.)%VS=35.0 (min.) |
| PS20 | - | Epoxy based finish paint. |

33.6.54.6 All weld edge preparation for site welding shall be applied with one coat of weldable.

33.6.54.7 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

33.6.55 Primer/painting schedule

Sl. No	Description		Surface preparation	Primer coat			Intermediate coat			Finish coat			Total min. (microns)	Colour shade
				System	Coat	Min. DFT/coat (microns)								
1	All insulated piping's. Fittings/ componentes, pipe clamps, vessels/tanks, equipments etc.		SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	as per NTPC colour shade/ coding scheme
2	All insulated piping's. Fittings/ componentes, pipe clamps, vessels/tanks, equipments etc.	Design temperature <60 ⁰ C	SP3/SP4	PS 5	2	25	-	-	-	PS4	3\$	35\$	155\$	
		Design temperature 60 ⁰ C-200 ⁰ C	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature >200 ⁰ C	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	
3	Constant load hanger (CLH). Variable load hanger (VLH) and other supports		SP4*	PS 19	1	40	-	-	-	PS17	1	30	70	
4	Valves													
	Cast/forged	Design temperature <95 ⁰ C	SP1/SP2/S P3	PS 9	1	20	-	-	-	PS9	1	20	40	
		Design temperature 95 ⁰ C-200 ⁰ C	SP1/SP2/S P3	PS 9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature >200 ⁰ C	SP1/SP2/S P3	PS 9*	1	20	-	-	-	PS9*	1	20	40	

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Sl. No	Description		Surface preparation	Primer Coat			Intermediate coat			Finish coat			Total min. (microns)	Colour shade
				System	Coat									
5	All structural steel componants	outside TG building and in SG envelope	SP4*	Inorganic Ethyle Zinc Silicate	1	75	PS18	1	75	a)) epoxy coat b)) final coat of paint PS1	2	25	250	
											1	30		
		Within TG building	SP4*	---do---	1	35	PS18	1	35	a)) epoxy coat b)) final coat of paint PS1	2	25	150	
											1	30		
6	Weld edges		SP6(hand cleaning by wire brushing)	PS13 (wieldable primer)	1	25	-	-	-	-	-	-	-	
\$ The first 2 finished coats (total min. DFT of 70 microns) shall be done at shop and the 3 rd finish coat (min. DFT 35 microns) shall be applied at site.														

33.6.56

Testing requirements:

The detailed testing requirements for power cycle piping and its components are given in the subsection for quality Assurance (QA). The requirements pertaining to testing given in this subsection if in variance with that given in QA subsection, then the more stringent of the two shall be followed.

ANNEXURE – 1**LIST OF POWER CYCLE PIPING**

The following list of power cycle piping is an indicative one and is provided for the guidance of the Bidder only. Items not mentioned but deemed necessary for making the system complete shall also be included.

SR. NO.	NAME		DESCRIPTION
1.0	Main Steam lines	:	From SH outlet to inlet of turbine
2.0	Main Steam Equalising line	:	Between RHS and LHS Main Steam lines
3.0	HP By-pass line	:	Between Main Steam line and CRH line
4.0	Cold Reheat line	:	Between HP turbine outlet and Reheater
5.0	Extraction line from CRH	:	Between CRH and Deaerator
6.0	Extraction line from CRH	:	Between CRH and H.P. heater
7.0	Extraction line from MS equalising line	:	From MS equalising line to auxiliary steam header
8.0	Steam supply to BFP Turbine	:	From the main and alternative source point to BFP Turbine Inlet
9.0	Extraction from BFP discharge	:	1. Between BFP discharge and H.P. By-pass 2. Between BFP discharge and PRDS
10.0	Warm up line for HP By-pass	:	Between MS line and H.P. By-pass line
11.0	Hot Reheat lines	:	Between Reheater and I.P. turbine
12.0	HRH equalising line	:	Between LHS and RHS Hot Reheat lines
13.0	LP By-pass line	:	Between HR line and condenser
14.0	Warm up line for LP By-pass	:	Between LP By-pass line and HR line
15.0	CEP Suction line	:	Between condenser hot well and CEP.
16.0	Main condensate line	:	Between CEP outlet and Deaerator through GSC, CPU, Drain Cooler, L.P. heaters.

SR. NO.	NAME		DESCRIPTION
17.0	CEP Minimum Recirculation line	:	Between main condensate line after CEP to condenser.
18.0	GSC Minimum Recirculation line	:	Between main condensate line after GSC to condenser.
19.0	Deaerator filling line	:	Between Condensate Transfer pump discharge and deaerator
20.0	Boiler filling line	:	Between Condensate Transfer pump discharge and Boiler bottom ring header /economiser inlet.
21.0	Fill up and Emergency	:	From Condensate Transfer pump discharge to make-up to condenser.
22.0	DMCW make-up tank	:	From Cycle make-up pump discharge to DMCW make-up tank.
23.0	Gravity Make-up to condenser	:	From condensate storage tank to condenser.
24.0	Condensate Dump Line	:	Between M.C. line after GSC and condensate storage tank.
25.0	Cycle make-up Pump Recirculation	:	Between Cycle make-up pump discharge header and Condensate Storage Tank.
26.0	Cycle make-up Pump Suction Line	:	From condensate storage tanks to Cycle make-up pump suction header.
27.0	By-pass line	:	For all control valves
28.0	By-pass lines for heaters (group bypass/individual bypass)	:	GSC, LP Heaters and HP Heaters.
29.0	CEP sealing line	:	Bidder's choice.
30.0	All extractions from main condensate line	:	For
			(a) Exhaust Hood spray
			(b) Turbine Flash Tank spray
			(c) L.P. By-pass spray

SR. NO.	NAME		DESCRIPTION
			(d) Water sealing of valves
			(e) Vacuum breaker line sealing
			(f) CEP sealing
			(g) Analytical measurements
			(h) Alkali flushing
			(i) Spray water to GSC desuperheater
			(j) Sampling
			(k) Instrument seal pot
			(l) Water sealing of valves & water washing of BFP Turbine
			(m) Spares
31.0	Turbine flash tank drain and vent line	:	From turbine Flash Tank drains to condenser hot well From flash vessels vent to condenser steam space
32.0	BFP Suction lines	:	Between Deaerator and individual BFP suction
33.0	Main Feed Water Line	:	From BFP discharge through HP heaters, control station up to economiser inlet header
34.0	Steam turbine drive for BFP	:	Associated piping
35.0	Inlet line to attemperation water header	:	From main feed water line to attemperation water header
36.0	Extraction from BFP	:	From BFP suction to sample cooler suction, BFP warm-up & Balance Leak-off line.
37.0	All extraction from Main Feed Water line	:	(a) To Auxiliary Steam pressure reducing de-superheating station

SR. NO.	NAME		DESCRIPTION
			(b) Stub for alkali flushing
			(c) HP By-pass spray
			(d) Blind Stub
			(e) Minimum re-circulation lines
38.0	Extraction lines	:	From various stage of turbine/CRH to L.P. Heaters, H.P. heaters, Deaerator and BFP Turbines.
39.0	All vents of H.P and L.P. heaters	:	(a) L.P. Heater vents to Condenser
			(b) H.P. Heater vents to Condenser
40.0	All cascade drain connection between heaters		(a) From each HP Heater to next lower pressure HP Heater
			(b) From the lowest pressure H.P. heater to Dearator
			(c) From each L.P. Heater to next lower pressure L.P. heater
			(d) From lowest pressure L.P. heater to flash vessel through drain cooler.
41.0	All Drip connections to Flash Tanks	:	(a) From H.P. Heaters
			(b) From L.P. Heaters (except the lowest pressure L.P. heater)
			(c) From Gland Steam condenser
42.0	Air Steam mixture line from Turbine Glands	:	(a) To GSC
			(b) To Atmosphere
43.0	Vapour extraction line for GSC	:	From GSC through vapour extractors to atmosphere
44.0	By pass Line to GSC	:	Through desuperheater to atmosphere

SR. NO.	NAME		DESCRIPTION
45.0	Air steam mixture line from condenser	:	To vacuum pumps
46.0	Drip connections to Deaerator	:	From H.P. Heaters
47.0	Connections for air outlet from vacuum pump	:	From vacuum pumps to atmosphere
48.0	Steam connection to Auxiliary steam header	:	From final superheater outlet
49.0	High Temperature Auxiliary Steam Header	:	One with interconnection
50.0	Auxiliary Steam from High Temperature Header	:	(a) To Gland Sealing unit
			(b) For mill inerting (if required)
			(c) For soot blowing
51.0	Low Temperature Auxiliary Steam Header	:	One with interconnection
52.0	Auxiliary Steam from Low Temperature Header	:	(a) For Deaerator pegging
			(b) For atomizing
			(c) For F.O. Heating
53.0	Extraction line from CRH line	:	From CRH line to auxiliary steam header

CHAPTER 10

10.0 MISCELLANEOUS PUMPSETS

10.1 GENERAL INFORMATION

10.1.1 Sump pumps specified hereinafter shall be used to dewater various sump pits in various plant areas like BTG area, Plant Water System, Ash Handling plant etc. where gravity draining is not be envisaged and to ensure general housekeeping

10.1.2 Pumps under this specification have been divided into following three (3) groups according to different duty envisaged and location of sumps/pits.

10.1.2.1 Group - A

The Group - A pumps shall be electric motor driven permanently installed vertical wet pit bottom suction volute type and shall handle drainage water, containing solid particles with sludges, polluted liquid, oils etc. from the area where they are installed. These pumps shall run intermittently by the use of high and low level switches in the sump. Particle size in the water shall not normally exceed 15 mm.

Group-A pumps shall also be provided to all indoor sumps of the plant and outdoor sumps of capacity 5 cu.m and above and underground cable vaults (if any) under the scope of this specification.

10.1.2.2 Group - B

These pumps shall be horizontal centrifugal electric motor/diesel engine driven portable type. Each pump set along with control panel etc. shall be mounted on a trolley for ease of transportation. These pumps shall be suitable for dewatering of pipelines of large diameter, if required and alike jobs and handling of liquids containing hard solid particles, sludge, polluted liquid, significant amount of fuel oil/HSD etc. and particle size shall not normally exceed 20 mm. These types of pumps shall be used in different plant areas.

10.1.2.3 Group - C

The Group - C pumps shall be vertical submersible portable type pump motor sets with suitable arrangement for carrying to any place and for lowering to and raising from various water reservoirs and pits. The pump motor set shall be suitable for handling water containing mud/sludge, solid particles, cotton waste, silica, ash particles, coal particles, polluted liquid etc. The particle size in water shall not exceed 20 mm. These pumps shall be utilised to dewater various deep sumps/pits (e.g. C.W pump house) in case of any eventuality.

10.2 CODES AND STANDARDS

10.2.1 The design, manufacture and performance of the sump pumps and drives specified, hereinafter, shall comply with the requirements of all applicable codes, the latest applicable Indian/British/American/DIN Standards, in particular the following:

10.2.2 IS-1710 : Vertical Turbine Pumps for clear cold and fresh water.

10.2.3 IS-5120 : Technical Requirements – Roto-dynamic special purpose pumps.

10.2.4 IS-5600 : Sewage and drainage pumps.

10.2.5 Hydraulic Institute Standards of USA.

10.2.6 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

10.3 GENERAL PERFORMANCE REQUIREMENT

10.3.1 The pumps shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated by the manufacturer.

10.3.2 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum head being at shut off.

10.3.3 Permanently installed vertical pumps shall be suitable for parallel operation. The head vs capacity, the bhp. vs capacity characteristics etc. shall match to ensure equal load sharing and trouble free operation throughout the range. Drive Motor shall not be overloaded when pump discharge is more than rated condition.

10.3.5 The static head requirement of portable submersible type sump pump may have a considerably wide range of variation depending upon the depth of pit being dewatered. While the pump shall have adequate capacity at the maximum head, the motor shall be sufficiently rated to cater for any overloading during the pump operation at its minimum possible head, i.e., maximum discharge.

10.3.6 Pump motor set shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards (latest edition).

10.4 SCOPE OF WORK

10.4.1 Pumps under groups A, B and C as listed in the Annexure- I along with drive units, couplings and other accessories mentioned below, as also those needed to make the pump-motor sets complete in all respect, for proper operation and maintenance. All motors in outdoor duty shall be provided with IP-55 enclosure and canopy. In addition to the accessories listed in Annexure-I, each pump set shall also include the following:

10.4.2 For the vertical Group - A sump pump motor sets

Two (2) nos. redundant ultrasonic type level transmitter (2 Nos.) with limiter technique shall be provided for alarming, auto start & auto stop. along with necessary junction box, local control panel, control cables etc. to achieve automatic starting/stopping of the sump pumps, and also ON/OFF indication for sump pump shall be monitored at DDC system. The entire assembly being mounted on the same base frame as mentioned above (item "b"). The control panel shall also be equipped with start/stop push button for starting/stopping individual sump pumps manually. Local control panel and cable shall be as per requirements described else where in the specification.

10.4.3

For each of the trolley mounted horizontal Group-B sump pump motor sets/pump-Diesel Engine sets

- a) One (1) no. 7.5 meters long hose for the pump suction and one (1) no.30 meters long hose for the pump discharge, either ends of each hose being provided with female hose coupling.
- b) One (1) no. 500 mm long straight pipe piece, with both ends flanged, one end matching with the pump suction nozzle.
- c) Two (2) nos. male type hose couplings, one of which is suitable for coupling with the above mentioned 500 mm pipe piece on one side and the 7.5 meters long suction hose on the other side, whereas the other is suitable for coupling with the pump discharge nozzle on one side and the 30 metres long hose on the other side. The pump suction pipe-piece and discharge nozzle shall be of flanged type. As such each coupling end that is to match with the pipe/pump nozzle shall also be flanged and shall be equipped with necessary bolts, nuts & gaskets.
- d) A foot valve (of Bidder's recommended size) with suction strainer, necessary coupling and matching piece/reducer (if necessary) to couple with the 7.5 meter long suction hose end.
- e) A starter panel complete with incoming switch/contacter, fuse, overload relays, start-stop push button, O/L reset push button, cable gland, wiring terminals, red and green indication lamps (LED type), necessary control cables etc., and also 50 metres length of flexible power cable with power plug at one end and arrangement to connect the other end with the starter panel.
- f) The pump motor set with a baseframe along with the starter panel, power cable, suction & discharge hoses etc., as mentioned above, shall be mounted on a suitable trolley with swivelling front wheel and having adequate fixing arrangement for all equipment, for operation without any undue vibration and with facility for being handled by a single operator.

10.4.5

For each of the portable submersible Group-C sump pump motor sets.

- a) Two (2) nos. 30 metres long discharge hose, having female hose coupling at both ends.
- b) One (1) no. 500 mm long pipe piece with both ends flanged, one end connected by necessary bolts, nuts & gaskets with the flanged discharge nozzle of the sump pump.
- c) One (1) no. male type hose coupling, one end of which is suitable to couple with the discharge hose and the other end is flanged, matching with the above mentioned 500 mm long pipe end and connected therewith by necessary bolts, nuts & gaskets.
- d) Suitable attachment for temporary seat of the pump motor set on the floor at sump bottom.

- e) One (1) no. 25 metres long submersible type power cable having a power plug at one end and a hermetically sealed (waterproof) cable gland for connection with the pump drive- motor at the other end.
- f) Suitable lugs and other attachments on the pump motor assembly frame, for hoisting and lowering of the pump motor set from and to the sump.
- g) One starter panel, having a plug socket as receptacle of the above mentioned power plug (item "e"), a 25 metre long incoming power cable with switch/contactors and fuse, start- stop push buttons, red and green LED type indication lamps, over load relays, O/L reset push button, cable gland etc., and also a suitable arrangement for temporarily mounting the starter panel, near the sump, where the portable sump pump-motor set is to work. The incoming 25 metre long power cable shall also be provided with a suitable power plug at one end.

10.4.6 Lubrication of one (1) initial fill and one additional fill after commissioning.

10.4.7 Rust inhibitor paint at Manufacturer's works.

10.5 DESIGN AND CONSTRUCTION

10.5.1 The design, construction testing and other details of the sump pumps and related accessories shall be in line with the stipulations and data in this chapter.

10.5.2 Each sump pump shall be equipped and coupled with a drive motor, with rating so selected as to have at least 15% margin over the maximum power required by the pump, throughout its range of operation. All other requirements of the drive motors shall be as stipulated in the Electrical Specification Vol IV.

The discharge rate of sump pump is uncontrolled. As such pump should be capable to operate even under a condition of as low as 25% of specified total head. Motors of group-B pumps should be designed to cater such eventuality.

10.5.3 All electrical items shall conform to the stipulations of Electrical Specification Vol IV as applicable.

10.5.4 All piping shall be as per IS-1239 of medium or heavy grade (as suited for the maximum operating pressure) and shall be either galvanised or painted with approved rust inhibiting paint. Pipe size shall be as per Appendix-II. Any matching piece/reducer required to match the pipe with pump nozzle, hose, etc. shall be provided.

10.5.5 All valves shall be steel body type as per applicable IS/BS/ANSI standard, with pressure class compatible with the maximum working pressure.

10.5.6 All hoses shall be of steel wire reinforced type. Pump suction hose shall be suitable for working under vacuum. Pump discharge hose shall be suitable to withstand the maximum pressure that it may be subjected to in all working conditions, including hydrostatic testing of the sump pump discharge line.

10.5.7 Pump suction strainer shall have openings large enough just to permit the entry of solids having maximum size as stipulated under clause no. 1.02.00.

10.6 Pumps

10.6.1 Pumps under Group-A shall be wet pit type, vertical shaft, centrifugal, vertical submerged suction, non-clog volute type complete with enclosed shaft, discharge pipe, head assembly thrust bearing and drive assembly, cover plates etc.

10.6.2 Pumps under Group-B shall be of horizontal shaft, single stage, end suction, radially split casing, centrifugal, non-clog design complete with common base plate, drive assembly etc. These pumps shall be trolley mounted portable type.

10.6.3 Pumps under Group-C shall be submersible pump-motor type, single stage and non-clog design and shall be portable type.

10.7 Casing

- a) Casing shall be so designed to allow free passage of specified maximum size of solid.
- b) Casing shall be designed to withstand the maximum shut-off pressure developed by the pump.
- c) The casings shall be cast, free from blowholes, sand holes, other detrimental defects. The casing shall be complete with suction and discharge connections.
- d) For pumps under Group-A adequate seal arrangement shall be made to keep leakage of liquid from casing to column assembly to minimum and adequate drain shall be provided in column assembly to permit escape of the leakage flow. The casing shall also include the bearing housing of the bottom pump shaft bearing.
- e) Casing of pumps under Group-B shall be provided with vent connections and drain connections with valves. These pumps shall be manually primed.

10.8 Impeller

- a) The impeller shall be open/semi-open non clog type, cast in one piece and specially designed to pass large solids or unscreened liquids. The clearance between stationary and moving parts should be such as to allow sustained performance without exclusive maintenance.
- b) Impellers of pumps under Group-A shall have provision for adjustment from an accessible location and for pumps under Group-C shall be capable of passing fibrous material like cotton waste, jutes, etc.

10.9 Pump Shaft

- a) Shaft size selected shall be such that critical speed is at least 20% away from the operating speed and the runaway speed.
- b) The shaft shall be ground and polished to final dimension and of ample size to withstand all stresses resulting from rotor weight, hydraulic loads and across the line starting. Shaft shall be provided with renewable sleeves particularly under stuffing boxes and other locations as recommended by pump manufacturers.

- c) The coupling between shafts shall be so designed that they become tight during pump operation.

10.10 Column Pipe (for pumps under Group-A)

The discharge pipe shaft assembly shall be flanged or screwed as per manufacturer's standard and standard length of each piece of column pipe shall be in conformity to the shaft piece lengths from consideration of easy handling.

10.11 Bearings

- a) Adequate nos. of properly designed bearings shall be furnished. Bearings for pumps shall be antifriction type and lubricated by grease. Line shaft bearings of vertical pumps shall also be grease lubricated. All necessary grease gun, grease cup and tubing shall be included.
- b) Thrust bearing of adequate design shall be furnished for taking the entire pump thrust arising from all probable conditions of continuous operation through out its "range of operation" and also the shut-off condition. The life of thrust bearing shall be 20,000 working hour minimum for the load corresponding to the duty point. The bearings shall be lubricated by grease from a location conveniently accessible. Design shall be such that the lubricant cannot contaminate the handling liquid.

10.12 Wearing Ring/Liner Plate

Renewable wearing rings/liner plates shall be provided either on impeller or on the casing or on both impeller and casing.

10.13 Stuffing Box

Stuffing Box of pumps under Group-A shall be of mechanical packing type. For pumps under Group-B and Group-C mechanical seal of reliable design shall be provided.

10.14 Coupling

Pump and motor shall be connected with a suitable flexible coupling. Coupling shall be provided with coupling guard.

10.15 Mounting Plate for Group-A Pumps and Base Plate for pumps under Group-B.

Each pump under Group-A shall be provided with a suitable mounting plate. The mounting plate shall be adequately sized to accommodate the level switches, discharge pipe, grease cups etc. if any. Pumps and motor under Group-B shall be mounted in one base plate. Base plate shall be of rigid construction properly ribbed as needed. Suitable drain with valve and drain funnel shall be furnished by the Bidder.

The necessary supporting plate, mounting frame, base plate etc. as required shall be supplied under this specification, along with anchor bolts, foundation bolts, pipe, sleeves etc. Lifting lug, eyebolts, etc. as required for the proper handling of each pump set shall be furnished.

10.16 Suction Bell

The pumps under Group-A, C shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

10.17 Material of Construction

For material of construction of various parts of data specification sheet shall be referred to.

10.18 **INSPECTION AND TESTING**

10.18.1 All pumps shall be tested at the shop for capacity, head, efficiency and brake horse power. These tests are to be done according to the requirements of "Hydraulic Institute Standard".

10.18.2 The pump integral accessories like thrust bearing, pump motor coupling etc. shall be subject to tests as per manufacturer's standard.

10.18.3 Test on motors, control panels, starter panels, cables shall be conducted as per the requirement of Vol.IV of this specification and as per Quality Assurance Plan to be approved by Owner during detail engineering.

10.18.4 After delivery/erection at site, pumps shall be operated to prove satisfactory and trouble free performance.

10.19 **DRAWINGS, DATA, INFORMATION REQUIRED**

10.19.1 Location and dimension of all sumps which requires assisted evacuation, present in the areas covered under the scope of this specification.

10.19.2 List of location of Group-A .

10.19.3 Characteristic curves of pumps showing effective head, pump input power, efficiency, submergence and NPSH, against capacity ranging from shut-off condition to 125% or rated capacity for Group A, B pumps and to 150% of rated capacity for Group C pumps.

10.19.4 Speed vs. torque curve of the pump corresponding to recommended mode of pump starting, super-imposed on speed vs. torque of the motor, corresponding to 80% and 100% rated voltage.

10.19.5 Diagram showing the type of lubrication system etc.

DATA SPECIFICATION SHEET

S. No.	Description	Group A	Group B	Group C
1	Pumps			
1.1	Rated Capacity	Capacity of each pump should be so selected to empty sump pit in 10 to 15 minutes	Twenty (20)	Fifty (50)
1.2	Total Dynamic Head at rated Capacity (MLC)	To be calculated with 10% margin on frictional drop	15	20
1.3	Minimum suction lift	-	6	-
1.4	Nos. required	These pumps shall be provided in all indoor sumps and outdoor sumps of 5 cum & above and underground cable vaults and CW pumphouse. Pumps shall be of 2 x 100% capacity for each sump.	Four (4) (2 electric motor driven and 2 diesel engine)	Four (4)
1.5	Duty	Intermittent		
1.6	Pump design standard	IS 5120/ IS 1710/ HIS		
1.7	Parallel operation	Yes	No	Yes
1.8	Material of Construction			
a)	Base Plate/ Cover Plate	MS – IS 2062	MS – IS 2062	MS – IS 2062
b)	Column Pipe	MS – IS 2062	MS – IS 2062	MS – IS 2062
c)	Casing	2% NiCi	2% NiCi	2% NiCi
d)	Impeller	2% NiCi	2% NiCi	2% NiCi
e)	Pump/ Impeller Shaft	SS 410	SS 410	SS 410
f)	Shaft Sleeve	SS 410	SS 410	SS 410
g)	Shaft Coupling	SS 410	SS 410	SS 410
h)	Shaft Bearing	BUSH GM as per IS 306	BUSH GM as per IS 306	BUSH GM as per IS 306
i)	Gland	CI IS 210 FG 260	CI IS 210 FG 260	CI IS 210 FG 260
j)	Fasteners	SS 304	SS 304	SS 304

Note : In all areas where Group A pumps are installed and will handle Sea Water like CWPB Pit the material of construction of all components of the pumps shall be Duplex Stainless steel.

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**TECHNICAL SPECIFICATION FOR
HORIZONTAL CENTRIFUGAL PUMPS**

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1.00.0 SCOPE

- 1.01.0 This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2.00.00 CODES AND STANDARDS

- 2.01.0 The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

2.02.0 List of Applicable Standards.

1	IS : 1520	Horizontal Centrifugal Pumps for clear cold fresh water.
2	IS : 5120	Technical requirements of roto dynamic special purpose pumps.
3	API : 610	Centrifugal pumps for general refinery service.
4	IS : 5639	Pumps Handling Chemicals & corrosion liquids.
5	IS : 5659	Pumps for process water.
6	HIS	Hydraulic Institute Standards, USA
7	ASTM-1-165-65	Standards Methods for Liquid Penetration Inspection.

- 2.03.03 In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

3.00.00 DESIGN REQUIREMENTS

- 3.01.00 The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve over the operating range of 40% to 120% of the duty point. The maximum efficiency of pump shall be preferably be within +/- 10% of the rated design flow as indicated in the data sheets.
- 3.02.00 The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of 15% more than the design head.

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3.03.00 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

3.04.00 Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

SPEED	Antifriction Bearing	Sleeve Bearing
1500 rpm and below	75.0 micron	75.0 micron

3.05.00 The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment.

3.06.00 The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

3.07.00 The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

3.08.00 Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

3.09.00 The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

4.00.0 DESIGN CONSTRUCTION

4.01.00 Design and construction of various components of the pumps shall conform to the following general specifications. for material of construction of the components, data sheets shall be referred to.

4.02.0 Pump Casing

4.02.01 Pump casing shall have axially or radially split type construction. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

4.02.02 Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

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4.03.00 Impeller

4.03.01 Impeller shall be closed, semi-closed or open type, and it shall be designed in conformance with the detailed analysis of the liquid being handled.

4.03.01 The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

4.04.00 Impeller/Casing Wearing Rings

4.04.01 Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

4.05.00 Shaft

4.05.01 The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

4.05.02 The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

4.06.00 Shaft Sleeves

4.06.01 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

4.06.02 Shaft sleeve shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

4.07.00 Bearings

4.07.01 Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished

4.07.02 The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

4.07.03 Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

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4.07.04 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

4.08.00 Stuffing Boxes

4.08.01 Stuffing box design should permit replacement of packing without removing any part other than the gland.

4.08.02 Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

4.09.00 Mechanical Seals

4.09.01 Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

4.09.02 The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

4.10.00 Pump Shaft Motor Shaft Coupling

4.10.01 The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

4.11.00 Base Plate

4.11.01 A common base plate mounting both for the pump and motor shall be provided. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

4.12.00 Assembly and Dismantling

4.12.01 Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

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4.13.00 Drive Motor (Prime Mover)

- 4.13.01 The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps are specified, the actual motor rating is to be selected by the tenderer considering overloading of the pumps in the event of tripping of operating pumps.

5.00.00 TESTING FOR HORIZONTAL CENTRIFUGAL PUMPS

The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.

5.01.00 Hydrostatic Tests

All pressure parts shall be hydraulically tested at 200% of pump rated head or at 150% shut off head whichever is higher. The test pressure shall be maintained for 1/2 hr. and no leakage shall be permitted. While arriving at the above pressure, the maximum suction head specified in Data Sheet shall be taken into account.

5.02.00 Performance Tests

- 5.02.01 All the pumps shall be tested in the Manufacture's Works at rated speed for capacity, efficiency and brake horse power. Pumps shall be given running test over the entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards or as applicable equivalent
- 5.02.02 The test shall be preferably conducted with the actual motor being furnished.
- 5.02.03 Only those pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and excessive vibration is observed during the performance test. Otherwise strip down examination is limited to bearing inspection only.
- 5.02.04 The pump accessories e.g. the thrust bearing, couplings etc. shall be subjected to tests as per manufacturer's standards.

5.03.00 Mechanical Balancing

All rotating components of the pumps shall be statically balanced. In addition to static balancing, rotating components of the pumps shall be balanced dynamically at or near the operating speed. Tenderer shall furnish acceptance norm for this test.

5.04.00 Visual Inspection

Pumps shall be offered for visual inspection by the bidder before shipment. The components of the pumps shall not be painted before inspection.

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5.05.00 NPSH Test

NPSH test shall be conducted with water as medium if required. NPSH shall not be mandatory in case type test certificates are furnished for the similar rating of pumps.

5.06.00 Noise and Vibration Measurement

Noise and vibration shall be measured during the performance testing at shop as well as during the site test.

5.06.01 The noise level shall not exceed 85 dBA. Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out with calibrated integrating sound level meter meeting the requirement of IEC:651 or BS:5969 or IS:9779. Sound pressure level will be measured all round the pump and motor set at a distance of one meter from the nearest surface of the machine and at a height of 1.5 m from the floor level. A minimum of six (6) points should be covered for measurement. The measurement shall be done with a slow response on the A-weighted scale. The average of the A-Weighted sound pressure measurements expressed in decibels to a reference 0.0002 microbars shall not exceed the specified value.

The tests shall be carried out on the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should necessarily be collected during the test.

5.06.2 Vibration check will also be done as per HIS. Vibration would be checked at thrust bearing locations on horizontal, radial and vertical direction. The acceptance limits would be as per HIS. The instrument used would be IRD 308 or equivalent with velocity pick-up. Vibration limits to be specified as per the speed of the pump.

5.07.00 Material Test Certificate

5.07.01 Material of the various pump components shall be tested in accordance with the relevant standards. Test certificates for these shall be furnished for the Owner's approval.

5.07.02 Where stage inspection is desired by BHEL/customer all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by BHEL/customer's inspector who will stamp the material. In case mill test certificate for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by BHEL/Customer, as per the requirement of specified material standard. The sample for physical and chemical testing shall be drawn up in presence of BHEL/Customer's inspector who shall also witness the testing.

5.08.00 Non Destructive Testing

- (a) UT shall be carried out on shafts of diameter more than 50 mm.
- (b) DP tests shall be carried out on shaft and impeller.

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(c) No weld repair shall be allowed on cast iron.

5.09.00 Field Testing

- 5.09.01 After installation, the pumps offered shall be operated to prove satisfactory performance as individual equipment as well as a system run. If the performance at site is found not to the requirements then the equipment shall be rectified or replaced by the Vendor, at no extra cost to the Owner. The procedure of the above testing will be mutually agreed between the Owner and the contractor. Noise and vibration tests shall also be repeated at site.
- 5.09.02 Based on observation of the trial operation, if modifications and repairs are necessary, the same shall be carried out by the contractor to the full satisfaction of the engineer and then the performance and guarantee tests to be repeated at site as per relevant clauses of the specification.

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**TECHNICAL SPECIFICATION FOR
METERING PUMPS**

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1.00.0 GENERAL

- 1.01.01 Specification cover the design, material, construction features, manufacture, inspection, testing the performance at the vendor's/sub-vendor's works, delivery to site, erection, commissioning and testing of metering pumps.

2.00.0 GENERAL DESIGN FEATURES

- 2.00.01 Pumps shall be simplex positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit. Maximum pump stroke speed shall not exceed 100 per minute.
- 2.00.02 The stroke shall be continuously adjustable to give a capacity variation 0-100% range while the pump is running or stopped. Adjustment of capacity shall be done by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.
- 2.00.03 The stroke shall be continuously adjustable to give a capacity variation 0-100% range while the pump is running or stopped. Adjustment of capacity shall be done by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.
- 2.00.04 Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard $\pm 1\%$ of capacity setting.
- 2.00.05 Pumps shall be provided with an integral relief valve, spring operated to release pressure when delivery line blockage occurs.
- 2.00.06 Crankcase shall be constructed of high quality cast iron, which will also house the gearbox and guides of cross head.
- 2.00.07 Guided, controlled travel, double-ball check valves or equivalent, shall be provided both on the suction and discharge side.
- 2.00.08 Material of construction of the various parts shall be as per the details furnished elsewhere in the specification. However all parts coming in contact with acid shall be of Haste alloy 'B' and for alkali it should be of SS-316 only.
- 2.00.09 Suitable gland seal shall be provided to prevent leakage.
- 2.00.10 Electric drive motor particulars should follow enclosed electrical chapters.

3.00.00 TESTING

3.01.00 Testing and Inspection at Manufacturer's Works

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- 3.01.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this Specification and is in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted to Owner for approval before conducting the tests.
- 3.01.02 The Owner's representatives shall be given full access to all tests for which the Manufacturer shall inform the Owner allowing adequate time so that if the Owner so desires, his representatives can witness the test.
- 3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Owner.
- 3.01.04 The pump casing shall be hydraulically tested at 200% pump operating pressure or 150% of design pressure whichever is higher. The test pressure shall be maintained at least for ½ an hour.
- 3.01.05 The rotating parts of pump drive shall be subjected to static balancing.
- 3.01.06 All pumps shall be tested at the shop for capacity, volumetric accuracy, repetitive accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. and Indian Standards as applicable.
- 3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per manufacturer's standards. The test results shall be furnished to the Owner.
- 3.01.08 The combined variation of the pump and motor should be restricted within limits specified by Hydraulic Institute Standard, USA when the pump operated singly or in parallel.
- 3.01.09 All pumps shall be subject to strip down examination visually to check for mechanical damages after performance testing at shop.
- 3.01.10 Diaphragm of the metering pump shall be type tested as per applicable code/standard.
- 3.01.11 Performance test shall be carried out for the setting of pressure relief valve.
- 3.01.12 Test reports and certificates of all the above-mentioned tests to ensure satisfactory operation of the system shall be submitted to the Owner for approval before dispatch.

3.02.00 Test at Site

After erection at site pumps as detailed under different groups shall be operated to prove satisfactory performance as individual equipment as well as a system. If the performance at site is found to be not to the requirements, then the equipment shall be rectified or replaced by the Vendor at no extra cost to the Owner.

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TECHNICAL SPECIFICATION FOR PRESSURE & STORAGE VESSEL

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1.00.00 GENERAL

The following principal pressure and atmospheric vessels for the system has been covered in this part of specification.

1. Condensate Polisher Service vessels.
2. Condensate Polisher Resin Separation and Cation Regeneration vessel.
3. Condensate Polisher anion regeneration vessel.
4. Condensate Polisher mixed resin storage Vessel.
5. Alkali diluent Heating cum Storage Vessel.(hot water tank)
6. Activated carbon filter
7. Alkali Preparation Tank
8. Alkali Day Tank
9. Resin Injection Hopper
10. Acid Measuring Tank.
11. Acid Storage Tank
12. DM storage tank.
13. Alkali storage tank

1.01.00 Of these, the items specified from Sr. no. 1 to 6 shall be designed as pressure vessels and the rest shall be atmospheric vessels.

1.01.01 All other vessels, not specifically listed here, but required for the Bidder's system shall also meet the general requirements of this specification.

1.01.02 Process requirements of these vessels shall be governed by the requirements of the Condensate Polishing System, which will determine their design conditions. Following sections only indicate some of the minimum requirements which must be met, and the actual design of these vessels shall be better than these, if that is required from process considerations.

2.00.00 GENERAL DESIGN FEATURES

2.01.00 Design

2.01.01 Design of all pressure vessels shall conform to ASME Section VIII or acceptable equivalent international standard. Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 10% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction if any. Design pressure of condensate service vessels is indicated elsewhere in this specification. For all other pressure vessels, design pressure shall be at least 10 Kg/cm² (g).

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- 2.01.02 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.
- 2.01.03 Design of all horizontal cylindrical atmospheric storage tank containing water, acid, alkali and other chemicals shall conform to BS: 2594.
- 2.01.04 Design temperature of all pressure vessels and storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel/tank is likely to attain during operation.
- 2.01.05 In case, tank is subjected to vacuum; the same shall be taken care in designing the tank.
- 2.01.06 The design of Demineralised water storage tanks (Vertical type) shall conform to IS: 803. Supporting frame where required shall be in accordance with IS: 800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.
- 2.02.00 All vessels / tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end. Vessel / tanks ends shall be of dished design and constructed by forging, pressing or spinning process. Conical or flat ends shall not be accepted. All dished ends shall be stress relieved.
- 2.03.00 All the atmospheric tanks shall have sufficient free board above the "Level High"/"Normal Level" as the case may be. The overflow level shall be kept at least 20 cm or 10% of vessel height above the "Level High"/"Normal Level" for all the tanks except for the DM tanks for which a minimum height of 300 mm shall be provided over the "High Level". Further, a minimum 300 mm free board shall be provided above the top of overflow level to the top of the tank. Wall thickness of atmospheric tanks shall not be less than 6 mm.
- 2.04.00 Vessels coming under preview of IBR shall be designed accordingly.
- 2.05.00 Interior surfaces of all tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.
- 2.06.00 All welds on inner tank surface shall be free of voids, gaps craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding. Inside weld seams shall be ground flush and smooth applicable for corrosion resistant coating or lining.
- 2.07.00 All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps, craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
- 2.08.00 Weld splatter shall be removed.
- 2.09.00 All welding shall be performed by ASME qualified welders under Section-IX of ASME Boiler and Pressure Vessel code and welding electrodes shall be as per relevant Codes/Standards viz. AISC Section 1.17 etc.
- 2.10.00 The plates for cylindrical tanks shall be accurately formed in bending rolls to the diameters called for, and the completed shells be concentric and plump. Plates shall be cold-rolled by plate bending machine in a number of passes to true curvature and joined by welding.
- 2.11.00 Vessels seam shall be so positioned that they do not pass through vessel connections.

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3.00.00 MATERIAL OF CONSTRUCTION

3.01.00 All pressure vessels shall be fabricated from carbon steel plates as specified in datasheet A of this specification and lined internally. All atmospheric tanks shall be fabricated of material as specified in datasheet A and lined internally.

4.00.00 APPURTENANCES

4.01.00 Manholes

4.01.01 All the pressure vessels and horizontal type storage tanks shall be provided with manhole of 500 mm diameter minimum size, preferably at the top head, complete with cover plate, lifting handle, davit cap, nuts, bolts, gaskets etc. to ensure leak tightness at the test pressure.

4.01.02 The vertical type storage tanks shall be provided with a manhole of 500 mm dia on the top cover, if the diameter of the tank is 1200 mm or more. For the DM water storage tanks, manholes shall be provided as per IS:803.

4.01.03 All the vessels and tanks shall be normally provided with a six inch gasketed handhole located near the bottom of the straight side.

4.01.04 The required lining/coating for the inside surface of the manhole/handhole, nozzle and cover plate of the manhole/handhole shall be same as that of the respective vessel/tank.

4.01.05 Sight Glasses

All the vessels mentioned shall be provided with pad type sight glasses on their vertical sides. Locations of these sight glasses shall be as follows:

4.01.06 One with the centre line at the normal level of the bed top, and one near the bottom of the straight side, for each of these vessels.

4.01.07 In addition, item no. 1.00.00 shall be provided with sight glasses, with their center lines at each of the normal separated resin interfaces.

4.02.00 Lifting Lugs

All vessels of diameter 1200mm or greater shall be provided with a minimum of 4 lifting lugs. Smaller vessels shall be provided with at least 2 lifting lugs.

4.03.00 Vessels Supports

Adequate supporting arrangements like straps, saddles, skirt rings, or legs of steel shall be provided to transfer all loads to the respective skid structures.

4.04.00 Vessel Internals

The internals for pressure Vessels shall be designed for a low pressure drop to promote uniform distribution and flow through the vessels and to withstand the full design pressure of the vessel in both directions.

Specification requirements for vessel internals are as follows:

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4.05.00 **Inlet water and Regenerant Distributors**

Hub and laterals with diffuser splash plates or header and perforated laterals. Material of construction shall be type 316 stainless steel, except for acid service which shall be of Hastelloy B.

4.06.00 **Underdrains**

Same as above with screened laterals with internal perforated pipes, and rubber-lined false bottom. For resin separation/regeneration/mixed resin vessels, it may have fully screened bottom (NEVA – clog type with para Septanurse screen, fully supported by subway grid, or equal).

4.07.00 For lined vessels, they shall also be lined in the same manner as the internal surfaces of these vessels. For the caustic diluent heating/storage tank, they shall be of type 304 stainless steel construction.

4.08.00 **Internal Fasteners**

All internal fasteners shall be of type 316 stainless steel and heavy duty locknuts shall be used throughout.

4.09.00 **Piping Connections**

All lined vessel connections and connections in unlined vessels 25 NB and larger shall be to ANSI 300 lb class. Flat face flanges shall be used throughout. Nozzle material shall be ASTM-A-106. Grade B. schedule 80 pipe. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full-face gaskets.

4.10.00 All vessel connections in unlined tanks smaller than 25 NB shall be screwed to ANSI 2.1 for schedule 80 pipe.

4.11.00 **Resin Traps**

Outlets of each of the condensate polisher service vessel and the waste effluent header of the common external regeneration facility, shall be provided with a resin trap. These resin traps shall be a minimum, conform to the following:

4.11.01 The resin trap shells shall be of steel construction and lined internally with saran or Polypropylene. The internals for all traps shall be johnson well screen type, of 316 stainless steel in both directions, resin traps located in processes effluent lines shall have a screen opening that does not exceed 120 percent of the associated process vessel under drain screen opening. Resin traps located in waste effluent headers shall have a screen opening of approximately 60 mesh.

4.11.02 Each resin trap shall be fully piped and valved for inplace manual back flushing.

5.00.00 **SPECIFIC DETAILS**

5.01.00 **Alkali Diluent Heating – Storage Tank (Hot water tank)**

One (1) no. hot water tank for heating of alkali diluent water with (2X50%) electric heating coil, adequately insulated of stainless steel construction shall be provided. The capacity of tank shall be minimum 20% higher than the maximum water demand. This tank shall be provided with burn out protection, pressure relief valve, level switches, temperature

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indicator etc. The heaters shall be sized for heating the water from a temperature of 15 to 50 deg. C in 5 hours at the outlet of ejector.

All tank internals, including the inlet water tail pipe, shall be fabricated of type 304 stainless steel.

5.02.00 **Atmospheric Tanks**

Wall thickness of these tanks shall not be less than 6mm.

5.03.00 **Resin Injection Hopper**

The supplier shall provide a hopper type tank for resin make-up, using water slurry, to the condensate polishing systems. This make-up system will constitute a portion of the condensate polishing external regeneration system. The resin hopper shall have a conical bottom and a flat top. The top shall have a piano type hinged port, having a lifting handle, of sufficient size for easy resin loading. The resin shall discharge through a bottom connection to a water ejector for transport. Water shall be added to the hopper to assist in the resin transfer. The ejector discharge shall be to the resin separation-cation regeneration vessel. Demineralized water shall be used throughout for the resin transfer. Piping of the resin make-up system shall be the responsibility of the Bidder as a part of the external resin regeneration system.

a) **Capacity**

The resin make-up hopper tank shall be sized to handle up to 150 liters of as received new resin per single injection.

b) **Material**

The resin make-up hopper tank shall be fabricated of mild carbon steel having a minimum thickness of 6mm and lined.

5.04.00 **Chemical preparation and day tanks**

These shall be vertical cylindrical tanks. They shall be of carbon steel fabrication, lined and provided with full height level gauges right up to the overflow levels.

The alkali preparation tank shall be provided with a dissolving basket of type 316 stainless steel constructions, and a motorized slow speed stirrer mounted eccentrically to the tank by a bracket fixed to the side wall. The stirrer shall have impellers of type 316 stainless steel.

The alkali day tank shall be provided with an airtight cover complete with a breather arrangement, to prevent absorption of carbon dioxide from the atmosphere by the alkali solution contained in it. The overflow connection shall also be provided with a suitable seal for this purpose.

The tanks for ammonia solution (if applicable) shall also be provided with similar arrangements to prevent escape of ammonia vapour to outside.

5.05.00 **LINING**

All internal lining of vessels provided under this specification shall be of natural rubber, meeting the following minimum requirements.

5.05.01 **Hardness**

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Lining used may be soft rubber having a shore durometer reading of 65 on the A scale, or semi-hard rubber having a durometer reading of 65 on the A scale. Variations in hardness of the rubber lining between the different areas of a specific tank shall be within +/-5 durometer reading.

5.05.02 **Chemical Resistance**

The lining material shall be suitable for prolonged service in the chemical environment described below:

- Hydrochloric acid, 2 to 8% concentration, at temperature from 10 deg C to 50 deg C.
- Sodium hydroxide, 1 to 4% concentration, at temperature from 30 deg C to 50 deg C.
- 100 to 500 mg /l of sulphuric and hydrochloric acid combined. Ratio of concentration of these two acid 1 : 5 to 5 : 1 and temperatures from 10 deg C to 40 deg C.
- 1 to 10mg/l of sodium hydroxide at temperature from 10 deg C to 40 deg C.

The linings will be subjected to the condition (a) or (b) for intermittent periods of approximately one hour out of eight hours, and to conditions (c) or (d) remainder of the time.

5.05.03 **Thickness**

The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.

5.05.04 **Surface Preparation**

Prior to rubber lining all surfaces must be prepared in the following manner.

- Degrease surface prior to blasting.
- The surface is to be blasted with steel grit or sharp silica sand to a white and bright metal surface.
- All traces of grit and dust should be removed with a vacuum cleaner or by brushing. Care must be taken to avoid contaminating the surface.
- Immediately after blasting and removal of grit, the first coat of primer or cement shall be applied and allowed to dry.

5.05.05 **Protection**

After the lining is completed the vessels shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation erection, etc. They shall not also be stored in direct sunlight. No further welding or burning shall be carried out on the vessel, after application of the lining.

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All lining projecting outside of the vessel, shall be protected adequately from mechanical damages during shipment, handling, storage etc.

Suitable warning, indicating the special care that must be taken with respect to these lined vessels, shall be stenciled on their outside surfaces with the letter at least 12mm high.

Example:

“Warning – Tank is lined”

“Do not weld or Burn”

“Do not Store in Direct Sunlight” etc.

6.00.00

CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure and storage vessels shall conform to the latest revisions of the following standards, in addition to other standards mentioned elsewhere in the tender document subject to any modification and requirement, as specified here in after.

- | | | | |
|----|---------|---|--|
| a) | IS: 803 | - | Code of practice for design, fabrication and erection of Vertical Mild Steel cylindrical welded oil storage tanks. |
| b) | IS: 816 | - | Code of practice for use of metal arc welding for general construction in mild steel. |
| c) | IS: 817 | - | Code of practice for training and testing of metal arc welders. |
| d) | IS: 822 | - | Code of procedure for inspection of welds. |
| e) | IS:1363 | - | Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia to 24 mm). |
| f) | IS:1367 | - | Technical supply conditions for threaded fasteners. |
| g) | IS:2062 | - | Specification for weld able structural steel. |
| h) | IS:2002 | - | Steel plates for pressure vessels for intermediate and High temperature service including boilers. |
| i) | IS:2825 | - | Code of unfired pressure vessels. |
| j) | IS:3133 | - | Manhole and inspection opening for chemical equipment. |
| k) | IS:4049 | - | Specification for formed ends for tanks and pressure vessels. |
| l) | IS:4682 | - | Code of practice for lining of vessels and equipment for chemical processes Rubber Lining. |
| m) | BS:2594 | - | Specification for carbon steel welded horizontal cylindrical storage tanks. |

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n) ASME - Boiler and pressure vessel Section VIII code.

o) ASTM - American Society for Testing and Materials.

7.00.00 FABRICATION

7.01.00 The vessel ends for storage tanks of vertical type shall have flat bottom. However, the ends of horizontal storage tanks, and all the pressure vessels shall be dished design of Tori-spherical type designed.

7.02.00 The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.

7.03.00 All the joints (circumferential / longitudinal) shall be continuous butt welded, inside and outside. Connection shall be flush with inner surface of tanks and welded continuously on both sides of shell. Sharp inside edges shall be rounded to a minimum 3 mm radius.

7.04.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the engineers. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.

7.05.00 All pressure vessels and storage tanks except Demineralised water (D.M.) shall be fabricated complete and tested at manufacturer's works to ensure better workmanship.

7.06.00 Tank Connections

7.06.01 Bidder shall furnish all pipe material required for tank connection for the process requirement. In addition to these, additional connections, if required by the Owner for the inter-connection of their piping, instrumentation etc. shall also be provided. Such additional requirement will be intimated to the successful Bidder later and Contractor shall provide these fittings to match with the Owner's items. Adequate pipe support attachments in the external surface of the tank/vessel shall be provided for Owners pipes for all the vessels/tanks. All lined vessels connections shall be conforms to ANSI 300 lb class. Nozzle material shall be ASTM-106 Grade B, Schedule 80.

7.06.02 All flanged connections should be supplied complete with matching counter flanges, nuts bolts and gasket materials. The flange design, (thickness and drilling etc.) shall match with the interconnected piping flanges.

7.06.03 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS:1367. However, internal fasteners if any, shall be of IS:316 /SS-304 or Hastalloy-B as per the duty conditions.

7.06.04 Gaskets shall be of full face type.

7.06.05 Sight glasses shall be provided for the tanks/vessels as specified in the standard specification. The material for sight glass shall be high quality transparent PLEXIGLASS of sufficient thickness to withstand the test pressure. The sight glass shall be provided with suitable gaskets and bolts to ensure leak tightness at the test pressure.

7.07.00 Vessels Supporting Lifting Lugs

7.07.01 Adequate supporting arrangements like straps, saddles, skirt boards, pillars etc. shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.

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- 7.07.02 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with at least two (2) lifting lugs.
- 7.07.03 Material of construction for these vessel supports, saddles, lugs shall conform to IS:2062 of tested quality.
- 7.08.00 **Special Accessories Storage Tanks**
- 7.08.01 Vessel internals wherever required shall be provided as detailed out elsewhere in the specification.
- 7.08.02 All the pressure vessels and tanks shall be provided with drain connections along with drain valves of suitable size. Further all the atmospheric storage tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 7.08.03 All the pressure and tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created in the tank during maximum filling/drain-off rate. The maximum draw off rate for the DM storage tanks shall be intimated later to the successful bidder.
- 7.08.04 Various instrumentation and the fittings required for the same shall be supplied as elaborated in data sheets.
- 7.08.05 Water seal shall be provided for the overflow line of DM and degassed water storage tanks. The vent and overflow lines of alkali preparation /measuring / day tanks and vent line of DM storage tanks shall be provided with Carbon dioxide absorber of proven design to prevent contamination from atmospheric air. Carbon dioxide absorber shall preferably be located at ground level. The vent and overflow lines of Acid measuring tanks shall be provided with fume absorber using suitable packing material, such as pall rings/raschig rings.
- 7.08.06 Conservation vent valves shall be provided in the vent line of DM storage tanks so that, at a vacuum to the extent of 65 mm water column, the valve shall open to relieve the vacuum. Body and trim of the valve shall be Die Cast Aluminum.

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**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

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1.00.00 GENERAL INFORMATION

1.01.00 The general guidelines as illustrated in the subsequent clauses of this section shall be applicable for vertical pumps to be procured under the scope of this package.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out elsewhere in the specification, the equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations, as applicable, including all the latest amendments subsequent to the year of publication as mentioned below.

2.01.01 IS 1710/1989: Vertical Turbine Pumps for Clear, Cold and Fresh Water.

2.01.02 IS 5120/1977: Technical requirements - Rotodynamic special purpose pumps.

2.01.03 IS 5639/1970: Pumps for handling chemical and corrosive liquids.

2.01.04 IS 5659/1970: Pumps for process water.

2.01.05 IS 6536/1972: Pumps handling volatile liquids.

2.01.06 IS 9137/1978: Code for acceptance for centrifugal, mixed flow and axial
Flow pumps - Class 'C'

2.01.07 BS 5316 Acceptance tests for Centrifugal, mixed flow Part-I/1976
And axial flow pumps - Class 'C' Tests (ISO 2548/1973)

2.01.08 BS 5316: Acceptance tests for Centrifugal, mixed flow Part-II/1977
And axial flow pumps - Class 'B' Tests (ISO 3555/1977)

2.01.09 ANSI B 73.2M Vertical inline centrifugal pumps for chemical process 1984

2.01.10 API 610/1989: Centrifugal pumps general refinery services.

2.01.11 Hydraulic Institute Standards of USA (1983).

2.01.12 PTC 8.2/1965: Power Test Codes - Centrifugal pumps.

3.00.00 Accessories:

All the pumps under this specification shall be complete with following standard/special accessories.

3.01.00 Standard accessories:

- a) Pump motor coupling along with coupling guard
- b) Common base plates for pump and motor.

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- c) Lubrication system along with all internal piping, valves, fittings, specialties etc. as required.
- d) Counter flanges for suction/ discharge nozzles along with fixing nuts, bolts and gaskets.
- e) Anchor bolts, nuts, seating steel works, etc. as necessary for mounting the pump-motor unit on Civil foundations.
- f) Suitable vent (with valves)/ lifting/ handling attachments for the pump/ motor/ Accessories.
- g) Suitable drain connections with isolating valves as applicable.
- h) Set of "Special" Tools & Tackles for Pumps and motors, if any.
- i) Erection and commissioning spares, "on as required" basis.
- j) Bidder shall provide various drawings, data, calculations, test reports/ certificates, Operation and maintenance manuals, As-built drawings, etc. as specified and as necessary.

3.02.00 Services included in Bidder's Scope:

3.02.01 The pumps shall be guaranteed to meet the performance requirements as specified vide datasheet – A and also for trouble free operation after commissioning.

4.00.00 TECHNICAL REQUIREMENTS:

4.01.00 The pumps shall be Electric motor driven.

4.02.00 The Pumps shall conform to HIS

4.03.00 Vertical type pumps with 1500rpm.

4.04.00 Minimum efficiency of vertical pump will be 40%.

4.05.00 No negative tolerance shall be permitted in rated capacity & TDH.

4.06.00 No negative tolerance shall be permitted in efficiency at rated capacity.

4.07.00 The shut off head of pumps shall be at least 115% of pump rated TDH.

4.08.00 The pumps shall be capable of developing the required total head at rated capacity for Continuous operation. The pumps shall operate satisfactorily at any point on the Q-H Characteristic curve over a range of 0% to 130% capacity and shall be suitable for Continuous operation between 30% to 130% capacity.

4.09.00 Selection of the pumps shall be such that the design point shall be met even with negative manufacturing tolerance.

4.10.00 The total head capacity curve shall be continuously rising towards the shut off, the pumps shall preferably be non-overloading type and stable.

4.11.00 The pumps shall be capable of running over the entire range of NPSH conditions required without any noise, vibration or cavitations.

4.12.00 The pumps shall be of stiff shaft design. The minimum internal clearances should be sufficiently more than the max. Static deflection of the shaft. Shaft size selected must take into consideration the critical speed as specified in API-610.

4.13.00 Pumps and motors shall run smooth without undue noise and vibration. The vibration shall be within 75 microns for pump - motor set. The noise level shall be limited to 85 dB at distance of 1.0M.

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4.14.00 High reliability of the pumps is an essential requirement and therefore it gets weight age over its efficiency. It is therefore essential that the bidder choose a standard proven model from the range of pumps manufactured.

4.15.00 If water handled by pump is dirty/ not suitable for lubrication/ cooling, the bidder shall provide requisite strainer/ filters, tanks, motorized valves, etc. after the tap off for the required service, the arrangement provided shall be subject to Purchaser's approval.

5.00.00 OTHER REQUIREMENTS:

5.01.00 The materials of construction for various components specified are the minimum Requirements indicated in datasheet – A section C and materials of construction for other components not specified shall be similarly selected by the bidder for the intended duty.

6.00.00 PAINTING FOR PUMPS:

- a) The surface of SS, Gun metal, brass, bronze and non metallic component shall not be applied with any painting.
- b) The Steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shop blasting etc. as per the agreed procedure.

For all the steel surfaces inside the (indoor installation) building, a coat of red oxide primes of min. thickness of 50 microns followed up with under coat of Synthetic Enamel paint of min. thickness of 50 microns shall be applied. the top coat shall consist of two coats each of min. thickness of 50 microns of synthetic enamel paint and thus total thickness shall be min. 200 microns.

7.00.00 PERFORMANCE REQUIREMENTS

7.01.00 Pump (s) shall preferably be designed to have the best efficiency at the specified duty point. Further, the pumps (s) shall be suitable for continuous operation at any point within its 'range of operation'.

7.02.00 Under all circumstances, the 'range of operation' of the pump (s) shall exclude any Unstable operating zone of the head-capacity curve.

8.00.00 DESIGN AND CONSTRUCTION

Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories. General design and constructional features of the pumps shall be as follows:

8.01.00 BOWL ASSEMBLY

8.01.01 This will be either a single, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of handling fluid.

8.02.00 IMPELLER SHAFT, LINE SHAFT AND HEAD SHAFT

8.02.01 Shaft size shall be selected on the basis of maximum torque to be applied on the pump shaft. Critical speed of the shaft shall be sufficiently away from the pump operating speed and in no case shall lie between 90% and 110% of the rated speed.

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8.02.02 Impeller shaft shall be guided by bearings provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall chamfer at the edges.

8.02.03 Line shaft may be single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the standard practice of the manufacture. For screwed coupling, directions shall permit tightening of the joint during pump operation.

8.02.04 Replaceable shaft sleeves shall be furnished at applicable location, particularly under stuffing box and at other locations, as considered necessary.

8.03.00 BEARINGS

8.03.01 SHAFT BEARINGS

Adequate number of properly designed bearings shall be provided for smooth and trouble free operation of the pump. Number of bearings shall consider the number of shaft pieces used and the critical speed of the shaft. Bearings shall be either lubricated by external clear water/oil/grease or self-lubricated. In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump.

8.03.02 THRUST BEARING

Thrust bearing of adequate size and capacity shall be provided to take the vertical thrust of the impeller arising out of the pump operation and dead weight of the rotating Components. Life of the thrust bearing shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load. Thrust bearing shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the bearing, while the pump coast down to stop in case of power failure of the station. Pre-lubrication of the thrust bearing, if recommended by the pump manufacturer, shall be taken care of in designing the lubrication system. Cooling of the thrust bearing, if necessary, shall be done by the handling fluid/external Water, depending on the fluid handled. Location of the thrust bearing may be at the pump body or at the driver, or at both depending on the requirement.

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SHEET

SECTION – D2
STANDARD TECHNICAL REQUIREMENTS
ELECTRICAL

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
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GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
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1.0 INTENT OF SPECIFICATION

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 machines
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.

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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 minimum 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: 4691 and 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.

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		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 3 OF 4
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	

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		VOLUME NO. : II-B
		SECTION : D
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		SHEET : 4 OF 4
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: <i>(To be given for motor above 55 kW unless otherwise specified in Data Sheet).</i> 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.		

BASIC TECHNICAL FEATURES

FOR HT/LT MOTORS

(FOR BHEL-PEM SCOPE PACKAGES)

					PROJECT	2X660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS,CHENNAI						
						OWNER	TAMIL NADU GENERATION & DISTRIBUTION CORPOARATION LIMITED					
						OWNER'S CONSULTANT	DESEIN PRIVATE LIMITED, DESEIN HOUSE,NEW DELHI					
						EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA					
						BHARAT HEAVY ELECTRICALS LTD. POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA		DEPT CODE	DRN	NAME BKR	SIGN	DATE
							E		DSGN	BKR	-SD-	13.01.15
									CHD	SL	-SD-	13.01.15
									APPD	RG	-SD-	13.01.15
					TITLE	BASIC TECHNICAL FEATURES FOR HT/LT MOTORS		DRAWING NO. PE-DC-412-155A-A001				
							SHEET 1 OF 7					REV. 01

REV	DATE	ALTD	CHD	APPD
01	13.03.15	BKR	SL	RG

REVISED AS PER TANGEDCO
COMMENTS DATED 13.02.2015

	2 x 660 MW ENNORE SEZ STPP BASIC TECHNICAL FEATURES FOR HT / LT MOTORS (FOR BHEL-PEM SCOPE PACKAGES)	Doc. No.	PE-DC-412-565-E003
		Rev. No.	01
		Dated	13-03-2015
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1.0 This document covers the basic technical features of high tension (HT) and low tension (LT) squirrel cage induction AC motors employed for driving auxiliaries of BHEL-PEM scope packages in **2 x 660 MW ENNORE SEZ STPP**.

2.0 CODES AND STANDARDS

The motors shall generally conform to IS 325/IEC-60034. LT motors above 10 kW with continuous duty (S1) shall be energy efficient IE2 conforming to IS-12615: 2011.

3.0 DESIGN REQUIREMENTS

3.1 General Requirements

The design ambient temperature shall be 50 deg C.

3.2 Supply system and rated voltage of motors

KW rating	Supply system	Rated voltage of motor
Above 1500 kW	11 KV	11 KV
Above 160 kW up to & including 1500 kW	3.3 KV	3.3 KV
From 200W up to & including 160 kW	415 V	415 V
Below 200W	240V	240V

3.2.1 Supply voltage & variations shall be as follows:-

Voltage variation (AC Supply) (+/-) 10%
Frequency variation (+) 3% to (-) 5%
Combined V & F variation 10% (sum of absolute values)

3.2.2 Motors shall be capable of running continuously at rated output for each of the conditions specified.

3.3 Motor Rating

Motor ratings shall be adequate to meet the requirements of the drive equipment. Motors shall be continuously rated at the design ambient temperature of 50 degree C and relative humidity of 85%. Maximum continuous motor ratings shall have at least a 10% margin above the maximum load demand of the driven equipment under entire operating range including voltage & frequency variation.

3.4 Starting Requirements

3.4.1 Motor shall start smoothly and rapidly. 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% of the motor's full load torque.

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

Minimum Starting Voltage requirement for all motors (except mill motors):

1. 85 % of rated voltage for motors up to 1000 kW
2. 80 % of rated voltage for above 1000 kW and up to 4000 kW
3. 75 % of rated voltage for above 4000 kW

- 3.4.3 The locked rotor current of the HV (11 kV) motors (except MDBFP motors) shall not exceed 650% of full load current inclusive of tolerance as per IS: 325 and for MV (3.3 kV) motors locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT motors (except energy efficient motors) locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT energy efficient motors above 10kW with S1 duty, locked rotor current shall be as per IS: 12615-2011.

- 3.4.4 The following frequency of starts shall apply to **HV (11 kV), MV (3.3 kV) & LT motors**

- i) Two nos. consecutive cold starts in quick succession with third start after 5 minutes in cold condition.
- ii) Two nos. consecutive hot starts in the interval of 15 minutes in hot condition.

- 3.4.5 Locked motor withstand time of motors under hot condition at highest voltage limit shall be as follows:

- a) For motors with starting time up to 20 sec.
 - at least 2.5 sec. more than starting time.
- b) For motor with starting time above 20 secs but not exceeding 45 secs.
 - at least 5.0 sec. more than starting time.
- c) For motors with starting time above 45 secs.
 - at least 10% more than starting time.

The starting time of the motor referred above is at minimum permissible voltage. For motors and in cases where the above requirements are not complied with, speed switches of approved make & type shall be provided to bypass the locked rotor protection for a pre-selected time during starting of motors. The speed switches shall have one NO & one NC contacts having maximum interrupting capacity of 5 Amps at 240V AC and 0.25 amps at 220 V DC.

3.5 Running Requirements

- 3.5.1 Motors shall run satisfactorily at a supply voltage of 80% of rated voltage for 5 minutes with full load without injurious heating to the motor.
- 3.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

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3.6 Stress during bus Transfer

- 3.6.1 Motors shall withstand the voltage 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.
- 3.6.2 Motor windings shall be adequately braced to satisfactorily withstand the mech. Stresses during above condition.
- 3.6.3 Motors shall be capable of withstanding heavy in-rush transient current caused by bus transfer without damage.
- 3.6.4 Motor and driven eqpt. Shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.7 Noise level

The maximum noise level for motors shall be in line with IS 12065.

3.8 Vibration

The maximum vibration for motors shall be in line with IS: 12075.

4.0 CONSTRUCTIONAL FEATURES

4.1 Degree of Protection

- 4.1.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. **Canopy shall be provided for outdoor motors.** CW motors (in case of screen prot. Drip proof) shall conform to degree of protection IP: 23 as per IS: 4691. The degree of protection for terminal boxes shall be IP 55 for outdoor area & IP 54 for indoor area as per IS 4691.

- 4.1.2 The stator laminations shall made from suitable silicon steel/magnetic steel sheet varnished on both sides and pressed to form a rigid core.

- 4.1.3 The rotor shall be of rigid cage construction with die cast aluminium / copper alloy / copper bars firmly wedged in bar slots and brazed to the end rings. The rotor cage shall be designed to operate satisfactorily under respective starting and load duty cycle.

4.2 Enclosure and Cooling

- 4.2.1 Motors shall generally have totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) enclosures or Closed Air circuit Air (CACA), the method of cooling conforming to IC-0141 or IC-0151 or IC-0161 of IS: 6362 up to 3000 kW motor. CW Motors may be screen protected drip proof (SPDP).

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

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

4.3 Class of Insulation

HV/MV/LT motors shall have class F insulation. The temperature rise of all motors shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits, 10deg C rise above the temperature limits specified in IS: 325 shall be permissible.

4.4 Bearings

4.4.1 Horizontally mounted motors shall have grease lubricated ball/roller or sleeve bearings. For HV/MV motors, the bearings shall be regreasable type and for LV motors, these bearings can be either sealed life lubricated type or regreasable type as per manufacturer's standard.

4.4.2 The vertical motors shall have a combined thrust and guide bearing on top and guide bearing at bottom. If the ball or roller bearings can take vertical thrust, thrust and guide bearing need not be provided.

4.4.3 After taking all motor driven equipment loads and thrust (if any) into account, the bearings shall be suitable for min. 20,000 working hours. Re-greasable bearings shall be provided with grease nipples and relief holes for on-line re-greasing and shall be suitable for 8000 working hours without changing of the grease.

4.4.4 The bearings of solidly coupled motors shall be of the same type as those of the driven equipment.

4.4.5 For motors below 15 kW shall be provided with sealed ZZ bearing.

4.4.6 Motors rated above 1000kW shall be provided with insulated end shield on non-driving end to prevent flow of shaft current.

4.5 Terminals and Terminal Boxes

4.5.1 Motors of rating 90 kW and up to 160kW will be controlled by air circuit breaker with numerical protection. For all motors of rating up to 90kW shall be provided with MCCBs. The terminal box of motors for HV (11 kV), MV (3.3 kV) & LT motors shall be designed for the maximum fault current for a duration of at least 0.25 secs.

4.5.2 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.

4.5.3 For HV/MV motors, the main terminal box shall be of phase-segregated type with clamping arrangement for the terminals.

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

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4.5.5 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.

4.5.6 Motor terminals and terminal leads shall be fully insulated with no bar live parts.

4.5.7 Separate terminal boxes shall be provided for space heaters and temp. Indicators. If this is not possible in case of LT motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) with double compression tinned brass glands shall be provided in terminal boxes.

4.5.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 180 and 90 degree for HT and LT motors respectively.

4.5.9 Cable glands and cable lugs as per selected cable sizes shall be provided in line with cable erection philosophy. For single core cable termination, gland plates shall be of non-magnetic material.

4.6 Grounding

Two separate earthing terminals suitable for connecting G.I. strip grounding conductor shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.7 General

4.7.1 Motors provided for similar drives shall be interchangeable.

4.7.2 An arrow block shall be screwed on the body of the motors on the non-driving end to indicate the direction of rotation of the motors.

4.7.3 Motors for Fuel oil unloading and drain oil pumps located in hazardous areas shall be with flame-proof enclosures in accordance with IS 2148 / IEC 60079.

a) Fuel oil area: Group - IIB.

b) Hydrogen generation plant area: Group - IIC

5.0 ACCESSORIES

5.1 SPACE HEATERS

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

The leads from space heaters of each motor shall be brought out to a separate terminal Box. Space heaters shall be mounted inside the motor in accessible places so that their removal and replacement is simple.

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5.2 RESISTANCE TEMPERATURE DETECTORS (RTDs)

5.2.1 HV/MV motors stator windings shall be provided with 12 nos. Simplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of winding temperature. The leads from RTDs of each motor shall be brought out to a separate terminal Box.

5.2.2 For HV/MV motors, each bearing shall be provided with 1 no. Duplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of bearing temperature. The leads from these RTDs shall be brought out to a separate terminal Box or the terminal box same as for winding RTDs.

5.3 DIAL TYPE TEMP. INDICATORS

5.3.1 For HV/MV motors, each bearing shall be provided with dial type thermometer with adjustable alarm contact and resistance type temperature detector. The indicators shall have 2 nos. NO contacts rated for 5A, 240 V AC and 0.5 A, 220 V DC for alarm/trip purpose.

5.4 Vibration monitoring pads

5.4.1 Provision shall be made in all HV/MV motors for mounting vibration detectors.

6.0 NAME PLATE

Motors shall have stainless steel name plate with all particulars as per IS: 325. In addition bearing identification number and type of lubricant is to be indicated.

7.0 PAINTING

Motor including fan shall be painted with corrosion proof paints of colour shade Siemens grey (RAL 7032).

8.0 TESTING

8.1 Type Tests

For HT & LT Motors, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

8.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

SPECIFIC ELECTRICAL REQUIREMENT

SL.NO.	PARAMETERS	UNIT	ENNORE
	MOTOR		
1	DESIGN AMBIENT TEMP	DEG. C	50
2	VOLTAGE SUPPLY AND VARIATION	VOLT	415V, $\pm 10\%$
3	FREQUENCY WITH VARIATION	Hz	50 (+) 3% to (-) 5%
4	COMBINED VOLTAGE & FREQUENCY VARIATION		10%
5	MAX ACCEPTABLE RATING OF MOTOR AT 415 V	KW	160 kW
6	SYSTEM FAULT LEVEL AND ITS DUARTION	KA	50 KA, 1 Sec
7	SUTABILITY OF TERMINAL BOX FOR FAULT LEVEL AND DURATION		50 KA, 0.25 sec
8	CLASS OF INSULATION & TEMP RISE LIMITED TO		Class-F and temp rise limited to Class-B
9	MIN. STARTING VOLTAGE		85%
10	MOTOR RATING FOR SINGLE PHASE SUPPLY		Upto 200W
11	MAXIMUM LOCKED ROTOR CURRENT	% OF FLC	For LT motors (except energy efficient motors) locked rotor current shall not exceed 700% of full load current inclusive of tolerance as per IS: 325. For LT energy efficient motors above 10kW with S1 duty, locked rotor current shall be as per IS: 12615-2011.
12	ACCEPTABLE NOISE LEVEL	DB	85dB at 1.0m in line with IS 12065
13	TYPE OF STARTER PROVIDED IN MCC		N.A.
14	DOP OF ENCLOSURE		Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. The degree of protection for terminal boxes shall be IP 55 for outdoor area & IP 54 for indoor area as per IS 4691.
15	SPACE HEATER REQUIREMENT		30KW & ABOVE
16	PAINT SHADE		Shall be confirmed during detailed engineering.
17	SPECIAL REQUIREMENT		For HT & LT Motors, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost. All motors shall be subjected to routine tests as per IS: 325 / IS: 12615. The motors shall generally conform to IS: 325 / IEC-60034.

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 19/06/2015
		SHEET 1 OF 2

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 19/06/2015
		SHEET 2 OF 2

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			



TITLE

2X 660 MW ENNORE SEZ STPP TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT

SPECIFICATION NO: PE-TS-412-155A-A001

VOLUME: II B

REV 00

SHEET

Explanatory notes for filling up cable list for routing through Win Path, 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	No. of cores	Cable code	Cable size
Voltage (e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)	
Code (see B below)			

- (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)
 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)

**TITLE****2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT**

SPECIFICATION NO: PE-TS-412-155A-A001

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SHEET

(C) CABLE CODES**PVC Copper**

A = Armoured FRLS
C = unarmoured FRLS

B = Armoured Non-FRLS
D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS
G = unarmoured FRLS

F = Armoured Non-FRLS
H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS
L = unarmoured FRLS

K = Armoured Non-FRLS
M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS
Q = unarmoured FRLS

P = Armoured Non-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

**TITLE**

2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT

SPECIFICATION NO: PE-TS-412-155A-A001

VOLUME: II B

REV 00

SHEET

SECTION – D3
STANDARD TECHNICAL REQUIREMENTS
CONTROL AND INSTRUMENTATION

**C&I SPECIFICATION
FOR
CONDENSATE POLISHING UNIT
FOR
2X660 MW ENNORE SEZ STPP**

DESIGN	KT
CHECKED	SK
APPROVED	SCS
REV- 00	DATE 15.06.15
JOB NO.	412

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- B. List of vendor deliverables for C&I for CPU Plant
- C. Specification for motorized valve actuator
- D. Specification for field instruments
- E. Specification for PLC
- F. Specification for UPS
- G. Specification for Control panels
- H. Drive control philosophy
- I. Applicable codes and standards
- J. Specification for Quality assurance & Testing
- L. Drawings
- M. Erection Hardware

B. C&I DELIVERABLES

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-412-155A-A001

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR CONDENSATE POLISHING UNIT							
2X660MW ENNORE SEZ TPP							
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY	CUSTOMER	FROM	USER	REMARKS
INSTRUMENTATION							
1	PE-V9-412-155-I901	INSTRUMENT DATA SHEETS	A	-	VENDOR	C&I	
2	PE-V9-412-155-I902	INSTRUMENT SCHEDULE	I	-	VENDOR	C&I	
3	PE-V9-412-155-I903	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	A	-	VENDOR	C&I	
4	PE-V9-412-155-I904	FIELD JB TERMINATIONS /GROUPING DOCUMENT	I	-	VENDOR	C&I	
5	PE-V9-412-155-I905	QUALITY PLANS (CV,FE, Tx and Analyser)	A	-	VENDOR	C&I	
PLC PANEL							
1	PE-V9-412-155-I906	PLC CONFIGURATION DRAWING	A	A	VENDOR	C&I	
2	PE-V9-412-155-I907	PLC PANEL GA (INTERNAL & EXTERNAL) DRAWING	A	-	VENDOR	C&I	
3	PE-V9-412-155-I908	CONTROL SCHEMES (BLOCK LOGIC)	A	-	VENDOR	C&I	
4	PE-V9-412-155-I909	PLC INPUT / OUTPUT SIGNAL LIST	I	-	VENDOR	C&I	
5	PE-V9-412-155-I910	UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD	I	\$\$	VENDOR	C&I	
6	PE-V9-412-155-I911	UPS SIZING CALCULATIONS	I	-	VENDOR	C&I	
7	PE-V9-412-155-I912	BATTERY SIZING CALCULATIONS	I	-	VENDOR	C&I	
8	PE-V9-412-155-I913	CONTROL DESK LAYOUT / GA DRAWING	A	-	VENDOR	C&I	
9	PE-V9-412-155-I914	PLC-OWS/PRINTER FURNITURE BOM	A	-	VENDOR	C&I	
10	PE-V9-412-155-I915	PLC CONTROL ROOM LAYOUT DRAWING	A	-	VENDOR	C&I	
11	PE-V9-412-155-I916	PLC CATALOGUE	I	-	VENDOR	C&I	
12	PE-V9-412-155-I917	PLC QUALITY PLAN & FAT PROCEDURE	A	-	VENDOR	C&I	
13	PE-V9-412-155-I918	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	`	VENDOR	C&I	
14	PE-V9-412-155-I919	PROCESS GRAPHIC MANUSCRIPTS PLC	I	-	VENDOR	C&I	
15	PE-V9-412-155-I920	PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	I	-	VENDOR	C&I	
16	PE-V9-412-155-I921	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	I	-	VENDOR	C&I	
17	PE-V9-412-155-I923	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	-	VENDOR	C&I	
18	PE-V9-412-155-I924	PANEL HEAT DISSIPATION DATA	I	-	VENDOR	C&I	
19	PE-V9-412-155-I925	MANDATORY SPARES BILL OF MATERIAL	A	A	VENDOR	C&I	
20	PE-V9-412-155-I926	PLC O & M MANUAL	I	-	VENDOR	C&I	
21	PE-V9-412-155-I927	PLC EARTHING SCHEME	I	-	VENDOR	C&I	
	Notes:	412 - Project No.					
		155 -SI No of MAX Package (CPU)					
		\$\$ -Approval by BHEL if Vendor BBU Item Approval by Customer if Customer BBU Item					

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.

C.SPECIFICATION

FOR

MOTORISED

VALVE ACTUATOR

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 18.05.15
			SHEET 1 OF 3	
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	2x 660 MW ENNORE STP		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT- INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☐ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ DURING DETAIL ENGG.		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902		
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			SECTION D		
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		SHEET	2 OF	3	
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	@ ENCLOSURE CLASS OF MOTOR	■ IP 68 □ FLAME PROOF			
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B			
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos., 1 IN EACH PHASE) □ -----			
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED			
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED □ NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	■ CONTACTORS □ THYRISTORS			
	TYPE	■ CONVENTIONAL □ SMART (NON-INTRUSIVE)			
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED			
	OPEN / CLOSE PB	■ REQUIRED □ NOT REQUIRED			
	STOP PB	■ REQUIRED □ NOT REQUIRED			
	INDICATING LAMPS	■ REQUIRED □ NOT REQUIRED			
	LOCAL REMOTE S/S	■ REQUIRED □ NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	■ REQUIRED □ NOT REQUIRED			
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIP, O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, PHASE LOSS, S/S IN LOCAL/OFF MODE, STOP PB OPTD, TORQUE OPEN/CLOSE CUTOFF)			
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	□ INTERPOSING RELAY □ OPTO COUPLER □ EITHER			
	QUANTITY	■ 2 NOs. □ 3 NOs.			
	DRIVING VOLTAGE	■ 20.5 – 24V DC □ _____ V DC			
	DRIVING CURRENT	■ 125mA MAX □ _____ mA MAX			
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms □ > _____ ohms - < _____ ohms			
	NO. OF IPR CONTACT(in case of IPR)	2 SETS SILVER PLATED CHANGEOVER CONTACT			
	IPR CONTACT VALUE (in case of IPR)	0.5A/220V DC or 8A/ 240V AC			
	IPR FEATURE (in case of IPR)	a) FREE WHEELING DIODE AND SELF RESET TYPE STATUS INDICATOR b) MANUAL FORCING/ OVERIDING FACILITY			
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	■ 1 No. □ 2Nos. / ■ 1 No. □ 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	□ 1 No ■ 2 Nos.	2 Nos. (ADJ.)	□ 1 No. ■ 2Nos.	
	CONTACT TYPE	2 NO + 2 NC			
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC			

	Data Sheet FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-ID-412-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 18.05.15
		SHEET	3 OF	3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	☒ REQUIRED ☐ NOT REQUIRED		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	$\pm 1\%$ FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY (NON INTEGRAL)	230V AC, 1 PH., 50 Hz		
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY		
	@ RATING			
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED		
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☒ IP 68 @ ☐		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET (9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ 2 NOS. ☐		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	OTHER CONTROL CABLE GLANDS	QUANTITY & SIZE : Cable gland suitable for 8Px0.5 sq mm & 2P x 0.5 sq mm Cable.		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.
NOTES: 1. SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. 2. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 3. ACTUATOR SHALL HAVE HARDWIRED CONTACTS FOR FOLLOWING SIGNALS (a) ACTUATOR IN LOCAL MODE (b) ACTUATOR IN REMOTE MODE. 4. ACTUATOR SHALL INCLUDE A DIGITAL POSITION INDICATOR WITH A DISPLAY FROM FULLY OPEN TO FULLY CLOSE IN 1% INCREMENTS. 5. BIDDER TO ENSURE AVAILABILITY OF SPARE 1NO + 1NC LIMIT SWITCH & TORQUE SWITCH. 6. SS TAG NAME PLATE SHALL BE PROVIDED. 7. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. 8. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, NI PLATED BRASS MATERIAL SHALL BE PROVIDED. 9. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE. 10. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY. -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. 11. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.				
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES				

D.SPECIFICATION

FOR

MEASURING INSTRUMENTS

CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

3.00.00 FIELD & MEASURING INSTRUMENTS (PRIMARY & SECONDARY INSTRUMENTS)

3.01.00 GENERAL REQUIREMENTS

3.01.01 Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

3.01.02 The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 1.08.00 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

3.01.03 The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

3.01.04 For plug in type instruments, The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.
Signal/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

3.01.05 Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

3.01.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

3.02.00 Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

- i. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet

of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.

- ii. Level switches for sump/tank level high/normal/ low/very low interlocks.
- iii. Level Transmitters (Type as per Owner approval) for open sump/tank/bunker/vessel/heaters.
- iv. Stand pipes on both side of tank for all level instruments (LT, LS & LG).
- v. Flow elements with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.
- vi. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.
- vii. DPG, DPT & DPS across the filters/strainers.
- viii. Tapping points/test points shall be provided.
- ix. All primary Instruments, hardware & JB's etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardware & JB's etc used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.
- x. All Thermocouples & RTDs shall be Duplex.
- xi. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).
- xii. All primary instruments installed at "Minus level or Floor" shall be with protection class of IP 68.
- xiii. Transmitters (all type) for monitoring & controls purpose.
- xiv. Pull cord, belt sway, zero speed switches, emergency stop P.B for conveyers, other limit switches, cable gland etc. of CHP which produce spark shall be provided with dust and flame proof enclosure conforming to IS-2148.
- xv. Lockable Deinterlock switches shall be provided for CHP as per requirement.
- xvi. Bidder shall provide electronics weighing in motion system as per IS-11547, hermetically sealed load cell of precision strain gauge type, 100% overload protection of cell and 250% overload protection for the construction; one calibrator attachment with two weighers.

- xvii. All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.
- xviii. All limit switch shall be conform to IEC-60947-5-1.
- xix. ~~At APH, temperature measuring device of different lengths forming grid shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.~~
- xx. ~~On both left and right sides of furnace, separate lines shall be laid and provided with furnace pressure transmitters having wider range than the furnace pressure transmitter.~~
- xxi. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services/application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.
- xxii. As for the water flow/ steam flow measurements, **necessary flow elements/transmitters are chosen in the process line and supplied such that their algebraic summations shall be mass balanced for calculating the system efficiency.**
- xxiii. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.
- xxiv. For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Acoustic, Ultrasonic, Radar based shall be provided by bidders as specified in NIT and as approved by owner.
- xxv. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxiv. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.
- xxvi. ~~For Turbine oil, HFO/LDO applications & H2 Gas application, zener protection on power supplies shall be included.~~
- xxvii. 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. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

FIELD INSTRUMENTS SHALL BE SUPPLIED & OFFERED AS PER DATA SHEETS SPECIFIED BELOW:

3.03.00 TRANSMITTERS, SWITCHES, GAUGES AND PANEL MOUNTED INSTRUMENTS**3.03.01 Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)**

Smart Transmitters of the electronic type shall be furnished.

All Transmitter shall be installed in closed LIE in the boiler area. Similarly transmitter for TG shall also be in LIE except the transmitters located in covered area on TG floor and these shall be mounted in LIR.

Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
- Body	:	Die cast Aluminum with epoxy coating for air & flue gas SS316 for other services
- Diaphragm	:	316 SS
- Measurement element	:	Teflon seal
- Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 mA Amp. DC (Two wires) HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. unit
Overall Accuracy	:	$\pm 0.04\%$ or better of Span for BTG package $\pm 0.065\%$ or better of Span for BO P packages $\pm 0.2\%$ or better of span for remote seal type transmitter.
Turn down ratio	:	100:1 in general
Stability	:	$\pm 0.15\%$ of URL for 5 years.
Response time	:	150 msec.
Power supply	:	24V DC nominal
Drive capability	:	600 Ohms nominal
Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Span and Zero	:	Locally adjustable, non-interacting

Zero suppression /
elevation : At least 100% of Span

Connection

- Process : 1. Half (1/2) inch NPT (F)
Quarter (1/4) inch NPT
with/without oval flanges
- Electrical : Suitable for Plug in type connection (Both
side of transmitter), unused entry with blind
plug.

Accessories

- For Absolute Pressure Transmitters: Two (2) valve SS316 manifold
- For Gauge & Vacuum pressure transmitter : Three (3) valve SS316 manifold
- For DP, level & flow transmitter : Five (5) valve SS316 manifold
- For oil and corrosive liquids : Separator diaphragm seals
- For all transmitters : Mounting bracket

Manifold should not be mounted on the transmitter, Manifold shall be on integral and standalone type. Snubbers/Pulsation dampers shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

3.03.01.01 Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

3.03.02 PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)

Applicable Standards : IS3624 - 1966/ISA-RP-8.1 except as
modified in spec.

Type/Construction : Bourdon/Sealed Diaphragm Piston
Actuated preferable. Indicators with
contacts are not acceptable.

Materials

- Bellows : 316 SS
- Bourdon tube : 316 SS
- Movement : 316 SS
- Encloser : Die-cast aluminum with stoved
enamel black finish. Epoxy coating
shall be provided for corrosive
atmosphere.
- Protective Diaphragm : Teflon

Accuracy	:	$\pm$ One (1) percent or better
Repeatability	:	$\pm$ 0.5(half) percent or better
Setting & Differential	:	Adjustable

Contact

- Number	:	DPDT /2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection - instrument	:	Half (1/2) inch NPT Male Process
Electrical	:	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
- Over range protection	:	One Fifty (150) percent of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 / 5 valve manifold	:	As applicable for all switches
- Self cleaning type pulsation dampners/Snubber (Material SS316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating diaphragm	:	For fuel oil & corrosive liquid lines.
Mounting	:	Local (in LIE/LIR for BTG package).

3.03.03

PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)

Applicable standard	:	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction	:	
-760 mm to 1.0Kg/cm ²	:	Bellows/Diaphragm
-Above1.0Kg/cm ²	:	Bourdon Tube
- Suction side of pumps	:	Compound gauge

Materials

- Bourdon tube	:	316 SS
- Bellows	:	316 SS
- Movement	:	316 SS
- Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating

		shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	:	$\pm$ One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local
	:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds	:	For all gauges
- Self cleaning type	:	Pump and compressor discharge lines
Pulsation dampener/snubber (S316)	:	
- Syphon	:	For all steam lines
- Protective separating	:	For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device	:	
Ranges 5 to 20 Kg/cm ²	:	Rubber blow out disc with open front construction.
Ranges above 20 Kg/cm ²	:	Neoprene safety diaphragm at the back with solid front construction.
- Over range protection	:	One Fifty (150) percent of full scale

Other Requirments

:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
:	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 M for Fuel oil & Corrosive liquid service.

- : Contact type pressure gauges are not acceptable for interlock & protection.
- : For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04

TEMPERATURE TRANSMITTERS

Type	:	SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display),
Accuracy	:	$\pm 0.10\%$,
Ambient temperature error	:	0.1% per 10°C change
Output	:	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class	:	NEMA 4/IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316.
Stability	:	$\pm 0.1\%$ or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	:	16 – 48 V DC
Calibration	:	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
Ref. Junction compensation	:	Provided
Span/zero adjustment	:	Locally adjustable, Non interacting
Auto calibration	:	Provided
Burn out protection upscale	:	Provided
Input - output isolation	:	Provided
Circuit ungrounded	:	Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.

Temp., Fuel oil temp. measurement
as per IBR rules and regulations

3.03.10 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection	:	
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

3.03.11 DIRECT MOUNTED LEVEL TRANSMITTERS (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

3.03.12 Ultrasonic Level Transmitter (for Water sump/Tank level, Raw water reservoir level, Cooling water fore bay level measurements)

Principle of Operation	:	Detection of reflected ultrasonic pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq.	:	10 KHz to 50 KHz (typical)
Display	:	Head mounted alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel & HART calibrator.
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo- level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	240 V AC 50 Hz / 24V DC
Signal Output	:	4-20 mA DC with HART (isolated) - 600 Ohm load.
Hysteresis	:	Fully adjustable preferred
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	± 0.25% of span or better
Resolution	:	± 0.1% of span
Temperature Compensation: To be provided with Transducer.		

Operating temp.	:	Transmitter-50 deg C and Sensor – 80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethane
Humidity	:	1% to 95% non condensing.
Enclosure	:	IP-67 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	3/4" ET
Mounting	:	2" – 4" NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.
		Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

3.03.13 **CAPACITANCE TYPE LEVEL TRANSMITTER**

The total system shall consist of capacitance probe, pre-amplifier and transmitter

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / 3/4" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signal.
Accuracy	:	± 1% of Full scale
Repeatability	:	± 0.5 % of Full scale
Load	:	Min 600 Ohms
Enclosure	:	Powder/Epoxy coated Die cast aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 °C.
Mounting	:	Wall / Surface
Supply voltage	:	240V AC, 50Hz / 24V DC
Response time	:	100 m sec or better
Cable connection	:	3/4" ET
Accessories	:	Counter flange, Cable gland, prefab cable if any
Preferable features	:	Alarm output contacts with adjustable set point facility

3.03.14 **GUIDED WAVE RADAR/RADAR LEVEL TRANSMITTER (FOR ACID SERVICES)**

Type	:	Guided wave Radar (Contact type)/Radar (Non contact type) as finalized by owner.
Application	:	For Turbine Lube oil tank, HFO & LDO tank level,

Output Signal	:	Pulse
Material of Construction	:	AISI 316
Sensor Seal	:	PTFE / higher based on temperature
Flow range	:	As required.
Linearity	:	0.25% or better.
Repeatability	:	0.02% or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Enclosure	:	IP 65
Accessories	:	Nuts, bolts, gaskets etc.

Transmitter

Electronics	:	Solid State
Power Supply	:	240V AC, 50Hz. UPS
Input	:	Input from Sensor
Display	:	4 1/2 digit LCD
Output	:	Isolated 4-20mA DC HART
Measuring Accuracy	:	0.5% of full scale range
Totalized Value	:	Required
Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	Clamping strip, bracket, prefab cable etc. Special tool kit for calibration/ configuration .

3.03.23 Flow Transmitter (Ultrasonic)

Type	:	ULTRA SONIC, 2-wired
Sensing element	:	Non-contact
Output	:	4-20mA with HART Protocol
Accuracy	:	± 0.1% FS
Supply	:	24 V DC
Enclosure class	:	IP-65

Transmitter

Mounting	:	On Nozzle
Mounting position	:	Top mounted
Housing	:	Plastic
Display	:	Head mounted LCD Display and remote LCD display
Process connection	:	NPT/Flanged
Electrical connection :	:	NPT
Turn Down ratio	:	1:100
Measuring range	:	Adjustable (as per process requirement)
Totaliser	:	Required
Accessories	:	As per process requirement Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during

detailed engineering.

3.03.24**Positive Displacement Flow Transmitter**

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

Type	:	Hall Effect Sensor
Body Material	:	AISI 316L/Die Cast Aluminium.
Wetted part Material (Like Piston, Bearing, gear etc)	:	AISI 316L/Die Cast Aluminium.
O ring material	:	PTFE / higher based on temperature
Flow range	:	As required.
Accuracy	:	$\pm 0.5\%$ or better of reading
Repeatability	:	$\pm 0.03\%$ or better.
Ambient temperature	:	50 deg C
Mounting	:	On-Line mounting with flanges of stainless steel.
Electronics	:	Solid State
Power Supply	:	230V AC, 50Hz. UPS
Display	:	4 1/2 digit LCD for Flow rate & totalized value.
Output	:	Isolated 4-20mA DC
Turn Down ratio	:	1:30
Totalized Value	:	Required
Housing	:	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Nameplate	:	Tag number, service engraved in stainless steel tag plate
Accessories	:	a) Clamping strip, bracket, prefab cable, battery etc.

Accessories	:	a) Isolating valves (for Bypass type only)
		b) Bolts, Nuts and Gaskets as required
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure

3.03.27 SIGHT FLOW GLASS INDICATORS

Type/Construction	:	Flapper type.
Materials	:	
Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW (Socket Welded)
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

3.03.28 SOLID FLOWMETER

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67 class
Accuracy	:	+/-1%
Repeatability	:	+/- 0.2%
Drift	:	Both zero & span $\pm$ 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication	:	yes, (HART) facility
Power supply	:	240 V AC, 50Hz. UPS
Ambient condition	:	Temperature -60 ⁰ C, RH-95% Environment – Highly Dusty

Accessories : Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. which ever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

3.03.29

Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation valves are laid to the application.

These bulk header are to be provided with **mechanical / electronic based automatic Drains.**

Individual moisture separator for O₂ analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

3.03.30

Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of $\pm 1.0\%$ inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P converters and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided in the :

- (a) Air supply line to valve positioners / power cylinders
- (b) Air supply line to electric to pneumatic converters.

- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

3.03.31 Electro-Pneumatic Convertors (E/P)

Two wire type E/P convertors with an accuracy of $\pm 0.25\%$ accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm² air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be S.S. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be 1/2" NPT (F). Zero/span adjustment facility shall be provided. The E to P converters shall **retain the pneumatic signal (last value) even in failure of control signal** and shall have **self volume boosters**. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

3.03.32 Solenoid Valves

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

- (a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
- (b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g., Pneumatically operated spray water block valve.
- (c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g., Pneumatically operated on-off type dampers.
- (d) For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., **double coil solenoid valve** (latch coil & relatch coil) shall be adopted.
Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.
- (e) Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable). Body material of solenoid valve shall be Die Cast Aluminum or SS316.
- (f) All solenoid shall be with varistor, LED indication, surge suppress diode and circuits.

3.03.33 Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting).
	:	b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line.

		The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm ² .
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysteresis	:	Less than 1% of full travel.

3.03.42**Junction Boxes**

- | | | | |
|-------|---|---|--|
| v. | Type | : | Flame proof/weather proof |
| vi. | Enclosure | : | IP-65/Explosion/Flame Proof as per area classification. |
| vii. | Material | : | FRP with protective Coating |
| viii. | Cable entry | : | Bottom or Side |
| ix. | Cable glands | : | Double compression type – Nickel plated brass with PVC hoods. |
| x. | Mounting | : | Indoor/Outdoor |
| xi. | No. of terminals | : | As required with standardization with 20% spare of each size & type. |
| xii. | Terminals | : | Phoenix/Wago (screw less cage clamp type spring loaded) |
| xiii. | Grounding | : | Two terminals for body and shield ground |
| xiv. | Door | : | Hinged, lockable type. |
| xi. | Suitable mounting clamps and other accessories shall be in scope of bidder. | | |
| xii | The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted. | | |
| Xiii | M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.) | | |
| xiv | Gasket (Normal)- Neoprene thickness 6.0 mm | | |

3.03.43**Interposing Relays (IPR)**

Electro magnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Free wheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from –20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V O inflammability class in accordance with UL94", IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided. The V A burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

3.03.44**RECORDERS (CHARTLESS)**

- | | | |
|-------------------|---|---|
| Type | : | Micro-processor based, Digital TFT display type |
| - No. of Channels | : | Forty Eight (48) point). |

		6 Nos. of recorders shall be supplied with BTG packages and the parameters shall be decided during detailed Engineering. Quantities of recorders for BOP packages shall be decided during detailed Engineering. (Simultaneous parameter display preferred)
Input Signal	:	Fully configurable multi range (Programmable) universal (input)
Recording method	:	Continuous with different colour, for each channel
Display colour	:	Selectable from 30 Colours
Bar graph facility	:	To be provided
Digital indication	:	To be provided
Accuracy	:	+/- 0.1 % for reading for DC V Input And 0.1 Deg for TC/RTD input
Programmability	:	Front key board
Data Storage	:	hard disk/ Flash Memory
Data Retrieval	:	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
Scan rate	:	≤ 20 m second for individual channel. Selection of scan time for individual channel is required.
Power Supply	:	240 VAC 1 Phase UPS
Ambient Temperature	:	0-50 Degrees
Mounting	:	Front panel mounted weather & Dust proof IP 65
Application software	:	Yes, To be provided
Internal Memory	:	400 MB or more
Screen	:	≥ 10.5" colour LCD TFT
Resolution	:	≥ 640 X 480 Pixels
Type of Display	:	i) Trends ii) Bar Graph iii) Digital display/ values
Event Sampling	:	1/2/5/10/30/60/120 sec.
Zoom & Scroll Facility	:	Required
OWS and printer connectivity port	:	Required
	:	Necessary software shall be supplied for uploading the data.
Communication	:	Additional MODBUS/PROFIBUS ports connectivity between recorder and third party systems.

3.03.45 DIGITAL INDICATOR

Type	:	Programmable electronic digital indicator with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user

		through key pad available on the indicator.
Number of digits	:	Four plus sign
Digit height	:	20 mm or larger
Display	:	Fluorescent red
Input over range/open sensor (T/C)	:	All digits to flash
Input hold time	:	0.7 seconds max.
Accuracy	:	$\pm 0.25\%$ of span
Power supply	:	240V AC, 50Hz
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Size	:	96x48 mm
Other Particular	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4 -20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

3.03.46 RECEIVER INDICATORS (SINGLE/DUAL CHANNEL)

Type	:	Analogue indicator
Input Signal	:	Universal input (T/C, RTD, 4-20 mA, Voltage)
Scale	:	Range fully configurable and programmable
Measurement Accuracy	:	$\pm 0.2\%$ of span ± 1 count
Resolution	:	0.5% Span
Dead band	:	$\pm 0.2\%$ of span
Repeatability	:	0.2% of span
Full scale response time	:	Less than two(2)seconds
Power Supply	:	240V AC, 50 Hz
Connection	:	Plug in type
Accessories	:	Mounting Bracket for Bins
Other Particulars	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4 -20 mA isolated required.

3.03.47 Temperature Scanner

Type	:	Microprocessor based Electronic Digital Scanner.
No. of channels	:	16/24 (as per the application)
Input	:	RTD /Thermocouple/4-20mA
Accuracy	:	± 0.1 of FS ± 1 count
Number of digits	:	4 digit (7 segment display with Engg. Units)
Digit height	:	12 mm or larger
Display color	:	Fluorescent red/green
Display mode for	:	

Input over range/open sensor	:	All digits to flash
Mounting	:	Panel mounting
Zero and Span	:	Adjustable by digital calibration
Serial communication communication	:	Isolated RS232/485 for modbus-RTU
Memory Capacity	:	5MB Flash
Alarm output	:	Required
Contact rating	:	2A at 220 V AC
Power supply	:	240 V AC/24 V DC
Properties	:	i. Any channel shall be configured for Data Logging ii. Channel to Channel online Isolation shall be provided iii. Real Time RTC Interface for Printer shall be provided
Operation Modes	:	Auto/manual mode, Run mode, Verify mode, Calibration Mode, Program mode.

3.03.48 **AMMETERS (AMM)**

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240 deg. With six times suppression scale
Zero adjustment	:	Screw on meter face
Accuracy	:	± 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating ≥ 30 KW and other critical application motors/drives.

3.03.49 **VOLTMETER:**

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	$\pm < 0.5$ %
Indication	:	Digital type 4 1/2 digit
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 230 V AC input power supply, UPS power supply, 24 V DC interrogation voltage & 220 V DC.

3.03.50 **FREQUENCY METER/MW METER (DIGITAL)**

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	4 1/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.2 Hz
Display	:	Red LED display.
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

3.03.51 AC CURRENT TRANSDUCERS

Input	:	0 - 1 A CT current
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.52 DC CURRENT TRANSDUCERS

Input	:	0 - 75 mV
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.53 AC VOLTAGE TRANSDUCERS

Input	:	0 - 110 V PT, Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.54 DC VOLT TRANSDUCERS

Input	:	System Voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.55 TRANSDUCERS FOR POWER

Input	:	CT and PT (1A) (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.56 TRANSDUCERS FOR FREQUENCY

Input	:	110 V PT Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.57 TRANSDUCERS FOR POWER FACTOR

Input	:	PT (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.58 TRANSDUCERS FOR MVAR

Input	:	CT & PT (110V/1A)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.59 DIFFERENTIAL FREQUENCY TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	110 V PT
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.60 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	System voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	$\pm 0.25\%$

3.03.61 PUSH BUTTONS (PB)/ ILPBs FOR ON/OFF, OPEN/CLOSE, START/STOP

Type	:	Momentary/Miniaturised Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage terminals and earth	:	2 KV for 1 minute between
Lamp Rating :-		
a) Voltage	:	240 V AC
b) Watt	:	2 Watt (approx.)
Colour		

5.11.00 Technical Specifications of Conductivity Analyser

- | | | |
|----|---------------------|--|
| a) | Applicable standard | ASME PTC 19.11-1970 except as modified in this specification. |
| b) | Type: | |
| | i) Cell | Flow through type/ removable type (withdraw able with sealing valve) |
| | ii) Monitors | Electronic (Microprocessor base d) i ndicating t ype with multi range facility |
| c) | Material : | |
| | i) Cell | Epoxy resin/SS316 |
| | ii) Electrode | Platinised/SS316 |
| | iii) Monitors body | Carbon steel/Aluminum/Polycarbonate |
| d) | Monitor output | |
| | i) | 4-20 mA D.C. with HART protocol spare out put |
| | ii) | 4-20mA DC with HART protocol for DDCMIS
Output load : 500Ω |
| e) | Power supply | 240V, AC, 50 Hz from UPS |
| f) | Accuracy | ± 1% of full scale span |
| g) | Stability | ± 1% of full scale per month
non-cumulative |
| h) | Repeatability | ± 0.3% of span |

- i) Annunciation contacts from monitors
 - i) Number 2SPDT
 - ii) Type Snap action micro switch
 - iii) Rating 5 amp, 240 V, 0.2 Amp, 220V DC
- j) Connection:
 - i) Cell
 - On line/pipe mounted
(ON LINE in sample table)
1/4 (Quarter) inch NPT (F) SCRD for
on-line type and Three quarter (3/4) inch NPT (M)
SCRD for pipe mounted.
 - ii) Monitors flush panel mounting
- k) Electrical Half (1/2) inch NPT (F) SCRD
- l) Accessories
 - i) Automatic temperature compensation in the range 0-100°C
 - ii) Ammonia (NH₃) removal equipment.
 - iii) Sample coolers
 - iv) Flow and pressure regulators
 - v) SS316 impulse tubing and fittings
 - vi) Isolation & drain valves as required
 - vii) Other accessories as required
 - viii) Adequate length of cables for connecting coils to monitors
 - ix) Sample rate set valves
 - x) Alarm settings and Alarm indications on monitor.
- m) Other particulars Cell shall be suitable for maximum pressure of 7 kg/cm² and maximum temp. of 100°C
- n) Response time ≤ 3 seconds

5.11.01 CONDUCTIVITY COMPARATOR

- Applicable Standard : ASME PTC 19-11-1970 except as modified this specification
- Type of cells : Flow through type / removable type with draw able with sealing valve)
- Transmitter : Electronic (Micro processor based) indicating type with multi range facility pipe mounted.
- Material of Cell body : SS316
- Material of cell Electrode : Platinised/SS316
- Output : 4 to 20mA DC isolated with HART output

Power Supply	:	240V AC, 50 Hz. From UPS
Accuracy	:	+/-1% of full scale span.
Stability	:	±1% of full scale per month non-cumulative
Repeatability	:	+/-1% of span
Protection class	:	IP - 65
Process connection	:	1/4 inch NPT (F) / SCRD for on line type. 3/4 inch NPT (M) SCRD for pipe mounted
Electrical connection	:	1/2 inch NPT (F) SCRD
Accessories	:	Automatic temp. Compensation in the range of 0-100 Deg.C

5.12.00

Technical Specification of pH Cell and Transmitters

- | | | |
|----|--------------------------------------|--|
| a) | Applicable Standard | pH electrodes shall conform to IS: 6804-1972 except as modified in this specification |
| b) | Type: | |
| | i) Cell | Measuring and Reference Electrode Combination with Flow through type (SS316/Polypropylene flow chambers) for power plant's steam & water application. Sensor shall not be affected by flow variation. Sensor shall be designed for power plant applications. |
| | ii) Monitors | Electronic (microprocessor based) indicating type with adjustable range facility. |
| c) | Material: | |
| | i) Measuring & reference | Toughened sensitive |
| | ii) Electrode | pH glass |
| | iii) Monitor body | Carbon steel/Aluminum/Polycarbonate |
| d) | Monitor output | i) 4-20 mAmp D.C. with HART protocol spare output
ii) 4-20mA DC with HART protocol for DDCMIS
Output load : 500Ω |
| e) | Power supply | 240V AC, 50 Hz from UPS |
| f) | Accuracy/repeatability | + 0.03 pH/+0.02PH |
| g) | Resolution | + 0.01 pH or 1 mV. 1C |
| h) | Stability | 0.02 pH per week |
| i) | Annunciation contacts from monitors: | |

- | | | | |
|----|-------------|------------|--|
| | i) | Number | 2 SPDT 'Hi' and 'Lo' |
| | ii) | Type | Snap action micro switch |
| | iii) | Rating | 5 amp, 240V AC, 0.2 Amp, 220V DC |
| j) | Connection: | | |
| | i) | Process | One-quarter (1/4)inch NPT(F) SCRD
ON-LINE |
| | ii) | Electrical | Half (1/2) inch NPT(F) SCRD |
| k) | Mounting: | | |
| | i) | Cell | Pipe Mounted |
| | ii) | Monitors | Flush panel mounting |
| l) | Accessories | | i) Automatic temperature compensation with fast response integral temperature sensors in the range 0-100°C
ii) Co-axial cable as required
iii) Sample coolers
iv) low and pressure regulators
v) Standard pH solutions
vi) SS316 impulse tubing and fittings
vii) Isolation & drain valves as required
viii) Electrode holders
ix) Other accessories as required
x) Sample rate set valves
xi) Alarm settings and indications on monitor.
xii) RFI/EMI shielded, weather and corrosion proof casing |

5.13.00 Technical Specification of Dissolved Oxygen Analyser

- | | | | |
|----|----------------------|--|---|
| a) | Applicable Standards | ASTM PTC 19.11-1970 except as modified in this specification | |
| b) | Type | Microprocessor based Electro-chemical | |
| c) | Material | Die-cast aluminum/SS/Polycarbonate | |
| d) | Output | i) 4-20 mAmp DC spare output
ii) 4-20 mAmp, DC Isolated output for DCS. | |
| e) | Supply | 240V AC, 50 Hz from UPS | |
| f) | Accuracy | <u>±</u> 5 % of reading | |
| g) | Response: | | |
| | i) | Sensitivity | <u>±</u> Two (2) per cent overall |
| | ii) | Time (sensor) | Less than 30 seconds for 90% step change. |
| h) | Connection: | | |

i)	Process	One quarter (1/4) inch NPT(F) SCRD
ii)	Electrical	Half (1/2) inch NPT (F) SCRD
i)	Accessories	i) Sample cooler assembly with shut off valve at cooling water inlet, with thermometer and reducing valve at sample outlet. ii) Flow stabilizer iii) Automatic temperature compensation iv) Other accessories as required v) Calibration device.
j)	Ranges	As per sample stream detail table
k)	Mounting	Flush
l)	Annunciation contacts:	
	i) Number	2 SPDT
	ii) Type	Snap action microswitch
	iii) Rating	5 Amp 240V AC, 0.2 amp 220V DC

5.14.00 Technical Specification of Silica Analyzer (SI OX)

a)	Applicable standard	ASME PTC 19.11-197 except as modified in this specification
b)	Type	Multi Channel (max of each Three channel) Colorimetric Analyzer (with auto reagent shut off feature in case of sample loss or power loss) built in phosphate inhibition feature. Micro processor based.
c)	Material:	
	i) Case	Die cast aluminum
d)	Cycle/Response Time	Twelve (12) minutes Maximum
e)	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
f)	Power supply	240V AC, 50 Hz from UPS
g)	Accuracy	± 1% of span
h)	Repeatability	± 2% of full scale
i)	Sensitivity	0.2 micrograms/liter
j)	Connection:	
	i) Process	Quarter (1/4) inch NPT(F) SCRD
	ii) Electrical	Half (1/2) inch NPT (F) SCRD
k)	Ranges	As per sample stream detail table

- | | | |
|----|------------------------|--|
| l) | Mounting | Flush |
| m) | Annunciation contacts: | |
| | i) Number | 2 SPDT |
| | ii) Type | Snap action micro switch |
| | iii) Rating | 5 amp 240V AC 0.2 Amp 220V DC |
| n) | Accessories | |
| | i) | Automatic temperature compensation between 5 to 50 deg C |
| | ii) | Automatic zeroing provision |
| | iii) | SS316 tubing & vessels |
| | iv) | All chemical reagents for 12 months operation of the analyzer |
| | v) | Sample rate set values |
| | vi) | Comprehensive diagnostic and alarm features. |
| | vii) | Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided. |

5.15.00 Technical Specification of Hydrazine Analyzer

- | | | |
|-------|------------------------|---|
| i) | Type | Microprocessor based Electrochemical |
| ii) | Case material | Die-cast aluminum/SS/Polycarbonate |
| iii) | Analyzer output | |
| | i) | 4-20 mA DC for spare output |
| | ii) | 4-20 mA DC isolated output for DDCMIS |
| iv) | Power supply | 240V AC, 50 Hz from UPS |
| v) | Accuracy | $\pm 2\%$ of full scale |
| vi) | Response Time | <4 minutes. |
| vii) | Sensitivity | 1.0 microgram/liter |
| viii) | Annunciation contacts: | |
| | - Number | 2 SPDT |
| | - Type | Snap action micro switch |
| | - Rating | 5A 240V AC, 0.2 A, 220V DC |
| | - Mounting | Flush mounting |
| ix) | Accessories | |
| | i) | Flow regulator |
| | ii) | Flow gauges |
| | iii) | Other accessories as required |
| | iv) | Sample rate set valves |
| | v) | Chemical reagents as applicable for 12 months consumption |

5.16.00 Technical Specification of Sodium Ion Analyzer

- | | | |
|----|------|---|
| i) | Type | Microprocessor based Continuous flow through sample type with sodium responsive |
|----|------|---|

		electrode and reference electrode having pH adjustment facility (Max 3 streams)
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer power supply	240V AC, 50 Hz from UPS
iv)	Analyzer output	i) 4-20 mA DC for spare output ii) 4-20 mA DC isolated output for DDCMIS
v)	Accuracy	Better than $\pm 5\%$ of full scale
vi)	Response Time	6 minutes. max
vii)	Sensitivity	0.1 ppb
viii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action microswitch
	- Rating	5A 240V AC, 0.2A, 220V DC
	- Mounting	Flush
ix)	Terminal points	All components piped & wired to terminal points
x)	Accessories	i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as required to make the system complete v) Chemical reagents as applicable for 12 months consumption

5.17.00 Technical Specification of Phosphate Analyzer

i)	Type	Microprocessor based Continuous flow through sample type with colorimetric detection system (Max 3 streams)
ii)	Case material	Die-cast aluminum/SS/Polycarbonate
iii)	Analyzer power supply	240V AC, 50 Hz from UPS
iv)	Analyzer output	i) 4-20 mA DC for spare output ii) 4-20 mA DC isolated output for DDCMIS
v)	Accuracy	Better than $\pm 4\%$ of full scale
vi)	Sensitivity	Better than 1 ppm
vii)	Annunciation contacts:	
	- Number	2 SPDT
	- Type	Snap action micro switch
	- Rating	5A 240V AC, 0.2A, 220V DC
	- Mounting	Flush
viii)	Terminal points	All components piped & wired to terminal points
ix)	Accessories	i) Flow regulator

- ii) Flow gauges
- iii) Sample rate set valves
- iv) Other accessories as required to make the system complete
- v) Chemical reagents as applicable for 12 months consumption

5.18.00 Technical Specification of Chloride Analyzer

- i) Type Microprocessor based Continuous flow through sample type.
- ii) Analyzer power supply 240V AC, 50 Hz, Single Phase from UPS
- iii) Analyzer output
 - i) 4-20 mA, DC spare output
 - ii) 4-20 mA, DC isolated output for DDCMIS
- iv) Accuracy Better than ± 10 % of full scale
- v) Sensitivity Better than 1 ppm
- vi) Range As per Requirements.
- vii) Annunciation contacts:
 - Number As per schedule, 2 SPDT
 - Type Snap action micro switch
 - Rating 5A, 240V AC, 0.2A, 220V DC
 - Mounting Flush
- viii) Terminal points All components piped & wired to terminal points
- ix) Accessories
 - i) Flow regulator
 - ii) Flow gauges
 - iii) Sample rate set valves
 - iv) Other accessories as required to make the system complete

5.19.00 Technical Specification of Chlorine Analyzer

- i) Type Microprocessor based Continuous flow through sample type with automatic temperature compensation.
- ii) Analyzer power supply 240V AC, 50 Hz, Single Phase from UPS
- iii) Analyzer output
 - i) 4-20 mA, DC spare output
 - ii) 4-20 mA, DC isolated output for DDCMIS
- iv) Accuracy 0.005 mg/ltr. or 1% of range.
- v) Sensitivity 0.001 mg/ltr. (1 ppb)
- vi) Range As per schedule.
- vii) Annunciation contacts:
 - Number As per schedule, 2 SPDT

-	Type	Snap action micro switch
-	Rating	5A, 240V AC, 0.2A, 220V DC
-	Mounting	Flush
viii)	Terminal points	All components piped & wired to terminal points
ix)	Accessories	i) Flow regulator ii) Flow gauges iii) Sample rate set valves iv) Other accessories as required to make the system complete

5.20.00 Technical Specification of Residual Chlorine Analyser

SENSOR

Method	:	Amperometric
Electrodes	:	Gold Cathode/Silver Anode
Cell Material	:	PVC
Electrolyte	:	Potassium Bromide

TRANSMITTER

Type	:	Microprocessor Based with self diagnostic features
Transmitter Output	:	4 – 20 mA
Enclosure Protection	:	IP65
Enclosure Material	:	Polyester coated Al.
Electrical Connection	:	½" NPT (F)
Mounting	:	FIELD
Display Type	:	LCD
Display Details	:	4 digit backlit LCD matrix
Diagnostics	:	Required
Meter Range	:	0-1 mg/l
Resolution	:	0.01 ppm
Area Classification	:	SAFE
Electromagnetic Compatibility	:	BUILT – IN
Temp. Compensator	:	AUTO – BUILT – IN
Temp. Compensating element	:	PT100

5.21.00 Technical Specification of Turbidity Analyser

SENSOR

Reference type	:	On Line
Operating principle	:	Alternating Light Source
Cleaning	:	Self Cleaning
Electrode holder – type	:	Flow Through
Body Material	:	CPVC
Process Connection	:	½" NPT (F)

E.SPECIFICATION FOR PLC

Bidder's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems.

The Bidder shall be fully responsible for detailed recommendations on the type, size, shielding, input balancing, ripple amplitude and frequency, isolation and grounding for field inputs and for the equipment furnished by the Bidder to achieve an installation with minimum noise from all sources.

The Bidder shall carefully review the Electrical Field Construction and cabling specifications given in Section-9 of this volume. If the performance of the equipment furnished by the Bidder is likely to be adversely affected in any manner because of these cabling and electrical field construction practices, the Bidder shall bring this to the attention of the Owner along with his proposal.

Any additional equipment, services required for effectively eliminating the noise problems shall be identified by the Bidder and shall be included in his lump sum proposal.

The Bidder shall be fully responsible for satisfactory elimination of any noise problems that evidence themselves following the installation of the equipment. All expenses incurred in the elimination of noise problems shall be borne by the Bidder.

2.14.00

SURGE-PROTECTION DESIGN CRITERIA FOR SOLID STATE/MICRO PROCESSOR BASED EQUIPMENTS/DCS/DDCMIS/PLC/UPS etc.

- i. All solid-state equipment shall be able to withstand the noise and surges inherent in a powerhouse. The equipment shall be designed to successfully withstand without damage to components and/or wiring, application of surge withstand capability (SWC) wave whose shape and characteristics are defined in ANSI publication C37.90a - 1974 entitled "Guide for surge withstand capability (SWC) Tests".
- ii. All solid state equipments, power supply to electronic cards, power supply to controllers, PLC panels, DDCMIS panels, SMPS power supply, UPS, battery chargers etc shall have external surge protection device with Pluggability and life indication as per IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10, to withstand max. 40 kA, 8/20 u Sec of Surge. The connection of the devices should be made as per TT configuration wherever applicable.
- iii. Signal lines shall have surge protection devices with pluggability and testability as per IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07, to withstand max. 20 kA, 8/20 u Sec of surges.
- iv. For data lines, communication lines, Ethernet/Can networks/LAN, Coaxial lines modular surge protection device should be used as per IEC 61643- 21:2000-09 to withstand a min of 2.5 kA, 8/20 u Sec of surges. The surge protection device should be used with the corresponding connector as being used for the lines i.e. RJ45, D-Sub, BNC, N-Type etc.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of

device shall at least be 10 K A, 8/20 μ Sec between core-core and 20 K A, 8/20 μ Sec between core-ground. The device shall be pluggable & on-site testable".

- v. All electronic cards/modules shall also be protected from failure against accidental/inadvertent application of high voltage upto 500V DC (common mode) even though these modules may be designed to operate at lower voltage levels such as 24V/48V.
- vi. In the case of DC powered system/subsystem/instrument, the design shall ensure protection against reverse polarity.
- iv. The Bidder shall provide details of production tests being carried out to fully satisfy the Owner that the proposed equipment meets the above requirements and to assure that the products furnished shall be of the desired grade.

2.15.00 General Tools and Tackles, Special Calibration Instruments:

Bidder must offer general tools & tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the plant.

2.16.00 PG TEST POINTS

- 2.16.01 Pressure, temperature and flow test points shall be provided in line with latest performance test code requirements.
- 2.16.02 In addition, pressure and temperature test points shall be provided for the following services:
 - (a) At the discharge of all pumps and fans
 - (b) At the inlet and outlet of the heat exchangers for the fluid media involved
 - (c) Adequate number at the Combustor at different zones
 - (d) At the inlet and outlet of each control valve
- 2.16.03 Pressure test points shall be complete with root valves and shall terminate with a nipple.
- 2.16.04 Temperature test points shall be provided with thermowell with a cap and chain.

4.02.00 Control System Basic Features/Design Requirements

4.02.01 Design Requirements

1. The instrumentation and controls shall be designed for maximum availability, reliability, operability and maintainability.

All components shall function in a satisfactory manner within their rated capacity under the specified conditions during the continuous service life of the plant.

2. All like instrumentation, control hardware, control and protective system should be of same make and model no. in order to achieve the goal of consistent control philosophy and to minimize the diversity of I&C equipment & spares.
3. Control system shall comply with following general failure criteria :
 - a. No single fault can cause the complete failure of the control system.
 - b. No single fault can cause the boiler or turbine/generator protection system to malfunction or become inoperative.

- c. The grouping of control functions into system blocks shall be arranged such that failure of any one block will only partly degrade the control of the overall system. Such degradation shall always be manageable by operator intervention.
 - d. The control system shall be structured to reflect the redundancy provisions of the plant so that no single fault within the control system can cause the failure of the duty equipment or make the standby equipment unavailable. Start command or stop command/trip command towards safety of process or process equipment shall be hardwired parallel from the **two different DO cards**.
 - e. As a result of a control system fault, a plant item or control function shall always respond to its controls at the actuator level (i.e., remote manual control). That item or control function shall be required to be isolated from automatic control system.
 - f. No single random fault in the entire automation and control system will cause a load loss, forced outage or unit trip.
 - g. No two simultaneous faults shall lead to or potentially cause damage to plant
 - h. Safety related instrumentation and control shall be designed with a fail-safe mode.
 - i. No single fault shall jeopardise the functioning of the entire system.
 - j. The control and automation system and the field instruments and actuators as well as its support systems, power supplies and data networks shall be immune to the electromagnetic interference and shall conform to the internationally accepted standards.
 - k. To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture.
 - l. When more than one device utilizes the same measurement or control signal, the transmitter and other components shall be fully equipped to provide all signal requirements without overloading and with proper isolation. Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.
4. Distributed control equipment shall employ modern distributed microprocessor based technology, as required to comply with the project specification and the DDCMIS system should not be more than 5 year old. A truly integrated DCS is envisaged with all the self sustaining subsystems communicating with each other over the bus network and thus ensuring that the system has a truly global data base.
5. The active control system including the plant protection system is the heart of the DCS system and therefore most stringent safety, availability and reliability

requirements have to be fulfilled by this subsystem. The bidder must bring out very clearly in his proposal how he intends to satisfy these requirements.

6. The control system shall be functionally distributed, (For Boiler, TG and BOP and similarly the control for 2 similar equipments like ID Fan A, B and C should be in different controllers & I/O cards) highly modular and arranged to reflect the functional grouping plant equipment and systems to be controlled. This functional group control strategy shall also form the basis for the partitioning of the controller to enhance the system reliability and flexibility. In case of redundant Analogue and Binary Signals, these will be connected to different input modules and different CPU. Similarly whenever inputs are more than one and needs temperature and pressure correction, the same shall be carried out in different CPU.

In case of redundant/multi Pumps/Drives for same service, all related Inputs & outputs of main pump/drive shall be in separate I/O cards and similarly all related Inputs & outputs of respective standby pump/drive shall be in separate I/O cards. Inputs/outputs of any two same services pumps/drives shall not be mixed in one common I/O card.

7. To meet the above failure criteria at s.r. no. 3, the I&C system shall incorporate self-checking facilities so that internal faults can be detected within the system itself prior to any resulting disturbance to the process. In addition, the protection and safety systems shall incorporate channel redundancy or diversity of measurement as well as self-checking and adequate test facilities. For some important systems, "on line" test shall be employed with no effect to the proper functioning of the protection system.
8. In order to make sure that the DDCMIS is an extremely user friendly system a centralized engineering subsystem is envisaged. An integrated subsystem has to be provided which takes over the complete task of planning, I/O allocation, generation of function schemes and wiring documentation (in design stage) and finally the automatic linking and loading of the planned functions in the target hardware.

The complete engineering of all the automation and data acquisition functions should be possible from this central tool. This shall include all modulating and sequence control functions as far as the automation is concerned, generation of plant graphics, logs and other MMI functions. In addition the central engineering system must support all service, maintenance and commissioning assistance functions.

9. For protection applications, multi-channel measurements shall be provided incorporating 2 out of 3 trip action. Facilities for the on-line testing of each independent channel shall be provided without loss of protection. Each measurement channel shall include discrete transmitters and instrument loops, i.e. multi channel measurement of the same process variable shall not be derived from common instrument. As per NFPA, Triple supply viz. 240VAC UPS, 24 V DC and 220 V DC shall be ensured for critical Boiler and Turbine protection. Both redundancy and diversity of trip criteria shall be considered to achieve sufficient guarantee against non operability or unnecessary operation of the

protection system. The principle of de energized to trip (Fail safe logic) shall be adopted.

10. Individual control elements shall be equipped with permissive to prevent the inappropriate operation of the item and "active interlocks" to trip the item in case of dangerous operation conditions.
11. Each of the multifunction controller together with its I/O and drive level control modules is to be understood as a self sustaining automation island, which executes the functional located to it independently and is not affected by a disturbance in the adjacent island. For the purpose of lateral communication between the automation islands, a high speed redundant bus (the so-called control bus) should be provided which should be solely responsible for the automation (control) signal exchanges.
12. Alarms shall be provided for all abnormal conditions over which the operator has control in the control room, plus those abnormal conditions which are of interest to the operator because they may affect plant operation or security.
13. The following colors shall be selected for equipment status indicating lights:
 - Red----energized, running, valve open
 - Green----de-energized, stopped, valve closed
 - Light yellow ----abnormal, discrepancy
 - White----control power available
14. The functions of DDCMIS System are achieved through bus communication units, bus interfaces, process controllers, I/O modules and computers. The system shall be versatile and provide the user, the flexibility to freely choose configuration and redundancy. The system shall ensure very high reliability and safety through complete distribution and decentralization which goes right down to the individual I/O level.
15. Interposing relays with suitable contact rating shall be provided between DCS/PLC and MCC/Swgr in Interposing relay panels for giving command signals ON/OFF or OPEN/CLOSE. Interposing relays shall have minimum 2 NO and 2 NC contacts.
16. All parameters on which protection is achieved through pressure/ temperature/ flow switches; the measurement shall also be made available through transmitters. **"Provision of transmitter/remote sensor will be applicable for 70% of total protection signals for such important services which will be decided during detailed engineering"**
17. Also the system shall have the flexibility to easily reconfigure any controller at any time, without requiring additional hardware or system wiring changes and without disabling the devices from their normal operating mode.
18. The system shall execute all control functions with the help of a set of pre-programmed functions resident in controllers.

The offered system shall have provision for open system architecture to establish communication to any other system using open system standards such as UNIX, WINDOWS NT, WINDOW XP/7, TCP/IP, OSF, MOTIF, SQL Access etc.

19. The system shall be provided with extensive diagnostic features so that a system failure can be diagnosed down to the module level giving location and nature of fault. Ease of maintenance and trouble-shooting shall be a primary consideration in equipment selection.
20. The system shall provide inherent safe operation under all plant disturbances and component failures so that under no circumstance safety of the plant personnel or equipment is jeopardized.
21. The design of the control system and related equipment shall adhere to the principle of "fail safe" operation at all system levels and provide reliable and efficient operation of the plant under dynamic conditions and attainment of maximum station availability.
22. The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, black out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.
23. All process input/output cards shall have built in galvanic/optical/electronic isolation for each input and output channel.
24. The failure of controller module and each I/O module shall be indicated on control cubicles and all operator stations.
25. For all the trip signals (very high/very low) employed for the boiler/Turbine Control System, **the alarms (High/Low) shall appear for correcting the process by the operators.**
26. For measurement of boiler metal temperature flue gas temperature, air pre-heater grid temperature etc., The bidder shall provide permanent/removable duplex type mineral insulated thermo-couples terminated in junction boxes at boiler platforms. Remote I/O unit has been envisaged for these inputs. The remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DDCMIS via DDCMIS I/O bus or via redundant soft link (either TCP/IP or OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from UPS or 24V DC source of respective unit. The unit enclosure shall be of weather proof, dust tight and water proof. Bidder shall provide necessary air conditioning unit, if require for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.
27. For measurement of turbine metal temperature turbine casing temperatures, stator winding temperature, Generator seal oil system, Turbine bearing temperature, Turbine oil temperature, Turbine bearing drain oil temperature, BFP turbine measurement parameters, M DBFP measurement parameters etc., The

bidder shall provide permanent/ removable duplicate type mineral insulated thermocouple/ RTD terminated in junction boxes at respective turbine side floors. Remote I/O unit has been envisaged for these inputs. The remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DDCMIS via DDCMIS I/O bus or via redundant soft link (either TCP/IP on OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from UPS or 24V DC source of respective unit. The unit enclosure shall be of weather proof, dust tight and water proof. Bidder shall provide necessary air conditioning unit, if required for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.

28. **8 Nos. temperature elements/sensors in each units control room** shall be provided for monitoring the room temperature.
29. On unit tripping, about hundred Engineers shall be informed through SMS automatically from DDCMIS. In case of tripping of major fans/pumps/HT drive the concerned Engineer configured in such a way shall get the SMS information.

To achieve the automatic SMS facility, GSM (global system for mobile Communication) with redundant Ethernet connectivity shall be provided by bidder for SMS facility. Same shall be connected with DDCMIS/OPC server/MIS server as decided during detailed engineering.
30. For Auto generation of trip message of unit & major fans/pumps/HT drive thru Email, Email facility in DDCMIS/OPC server shall be provided by bidder.
31. All the 4 nos. 40" LED TV monitors per unit and 2 nos. 40" LED TV monitors for common system at CCR shall be erected at the false roof top of central control room.

4.02.02 CONTROL SYSTEM PHILOSOPHY

- 4.02.02.1 In order to minimise the burden on the unit operator, all control functions within the operational load range shall be fully automated. The control system shall be structured in accordance with a well-defined control hierarchy to permit operator intervention at appropriate levels during abnormal modes of operation.
- 4.02.02.2 The automation shall meet the following objectives as minimum:
 - (a) Consistent start-up, shut down and running of the plant under all operational condition
 - (b) Achieve minimum run-up and loading time
 - (c) Maximize fuel economy during start-up, shut down and normal on load operation cycle
 - (d) Maximize plant life expectancy

- (e) Contribute to power grid during normal and disturbance condition
- (f) To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture. The system hierarchy shall be at four levels.

4.02.03 Different Level of Controls

4.02.03.1 Drive Level

- 4.02.03.1.1 The first and lowest level shall cover all the modulating, sequence and protection control functions directly associated with all remotely controlled plant items. It shall also incorporate all necessary interlocks, initiations and trip functions for starting and stopping a main drive motor.
- 4.02.03.1.2 Control at this level shall either be initiated directly from the remote manual control interface or automatically by the next hierarchical level.

4.02.03.2 Subgroup Level

- 4.02.03.2.1 The second level shall coordinate the control of all first level drives, both closed loop and open loop, associated with a particular functional subgroup. In the case of a pump subgroup, for instance, the permissive checks, the coordination of the operation of the suction and discharge valves, the main drive initiations and the basic modulating control loops shall be executed at this control level. The major monitoring functions (e.g. turbine supervisory measurements) shall also be identified with this level.
- 4.02.03.2.2 Typical control functions associated with this level are:
 - i. Auto- Start and stop initiation or set point guidance from the next higher control level
 - ii. Start-stop- Normal initiation of the auxiliary start and stop sequence.
 - iii. Auto Standby-Start initiation in the event of duty item failure.
- 4.02.03.2.3 A functional group consists of different units, which individually represent and control a part of the complete plant and can be divided into two or more groups. Every sub group is controlled by an independent sub group control, which controls the operation of various drives. Once a start signal issued by a functional group, the sub group control brings the sub group from one state into another operating condition by issuing command signals in a programmed sequence. It brings the sub group from a shutdown state into a working condition and vice-versa. The functional group instrumentation and control system co-ordinates the entire sub group controls belonging to one functional group.

4.02.03.2.4 Group Level

- 4.02.03.2.4.1 The third and penultimate level shall coordinate the individual subgroup control function (both modulating and sequence controls) within the main functional groups of the system.
- 4.02.03.2.4.2 The group co-ordinate the sub group of a functional group. Its main function is to

deliver start-up or shutdown command signals to the sub-group and change over from a faulty subgroup to the reserve sub group, the group co-ordination control supervises the actual and the required position of the switchgear in the sub group and then decides whether the sub group shall be switched "ON" or "OFF"..

4.02.03.2.4.3 The aforesaid concept of functional group control is independent of the control techniques-freely programmable.

4.02.03.2.5 Unit Co-Ordination Level

4.02.03.2.5.1 The fourth level, which stands at the apex of the hierarchical triangle, shall perform the overall unit coordination. It shall incorporate, for example, the master load control function which should regulate the load generated by the generator to the demand set point value. In general for automatic start-up and shutdown control, the sequential initiations of the functional group sequences should be generated at this level.

4.02.03.2.5.2 The typical sequence control functions to be implemented at this level would include:

- i. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown.
- ii. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown of a part/full.
- iii. The sequential transition to the various combination of subordinate functional Groups.

4.02.03.2.5.3 The modulating control functions to be implemented at this level would include the following:

- i. Unit load control with frequency regulation incorporating load balancing (remote set point adjustment from the CCR /LCR shall be provided).
- ii. Station load demand and demand rate limiting

4.02.03.2.5.4 In general the operator shall have direct access to all four control levels where these are identified, through the operator control interface located in the CCR.

4.02.03.2.5.5 Communication links shall be provided between the various control systems to allow for access to the system from any of the operator's interface stations.

4.02.04 CONTROL SYSTEM - LEVEL OF AUTOMATION

4.02.04.1 The unit control and monitoring shall be performed from control room by means of OWS/KB operation interface mounted on unit control desk, through a microprocessor based distributed Digital control monitoring and information system.

4.02.04.2 The unit shall be remotely controlled, but a fully automatic system of the plant shall be provided, i.e. all valves, motors, final control elements and other equipment that have to be operated during start up, operation and shut down, belonging to the Main Systems, shall be remotely controllable from unit control room by the operator through Distributed digital control monitoring and Information system.

4.02.04.3 Subordinated drives belonging to one main aggregate shall be managed by means by sub group control systems. Automatic open/closed loop controls shall be installed wherever it is possible to lighten the work of the operation.

4.02.05 CLOSED LOOP CONTROL SYSTEM (CLCS)

4.02.05.1 The CLCS shall control the process variables automatically both under steady state and dynamic conditions with in the limits specified under guarantee clauses over the entire operational range of the equipment/system.

4.02.05.2 The CLCS shall have the following features:

- (a) Provision of predictive and/or adaptive controls in addition to PID controls as required by the system. Availability of **advance control techniques/Algorithms** ensuring process optimization.
- (b) Set point adjustments and indication from operating work stations/ KBs for process variables which need to be changed during load changes, start-up, shutdown, normal or under any other emergency conditions.
- (c) Fixed set point at the software level/hardware level (only changeable by the maintenance engineer) and indication for those process variables which need not be changed with respect to load or otherwise.
- (d) Bias adjustment with indication where a single controller is controlling more than one final control element (control valve, control damper, speed drive etc.) to maintain the same process variable.
- (e) Auto and manual control facility shall be transferable in both directions without bump of the value of the process variable to control the parameter during manual operation. Both master Auto Manual station and Auto / Manual station for individual control element shall be provided in OWS. Auto tuning facility shall be an inherent feature of the DDCMIS. Availability of control loop of process parameters in auto for different loads. If required, the system shall have the feasibility of **auto changing of P ID const ants (K const ants)** in micro-processor/controller for different loads so as to avoid hunting of control valve.
- (f) Characterization of final control element to suit the various applications with respect to load or otherwise as dictated by the process.
- (g) Function generator to provide necessary characterization or variation of set points with respect to load, speed or any other requirement.
- (h) Soft Auto /Manual station interlocks to drive the final control elements to a suitable position for safe plant operation in the event of process/equipment abnormal conditions.
- (i) Blocking/Interlocking function as dictated by process/equipment.
- (j) Monitoring of loop failures or any hardware failure in the loops.
- (k) Fail safe operation of final control elements in case of failure of motive power or

Signal.

- (l) Redundancy criteria of sensors for CLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.
- (m) Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.06 OPEN LOOP CONTROL SYSTEM (OLCS)

4.02.06.1 Protection, interlock and sequence controls constitute OLCS. This system shall enable the operator for safe start up and shutdown and carryout normal operation both from control room and local areas. Protection and Interlock shall be provided for all the equipment and system to safeguard the equipment against abnormal conditions which may result in the failure and less utility of the equipment and protect the operating personnel. Controls shall be provided to start/shutdown various systems and/or any equipment with associated auxiliaries and to operate the Unit on line with optimum number of operations and higher safety.

4.02.06.2 The OLCS shall have the following features as a minimum:

Features-General Requirements

- (a) The logic and sequence control shall be Digital distributed microprocessor based and programmable.
- (b) Enable the operator to start/stop various unidirectional motors, to open/close various valves and dampers and carry out inching operation of bypass valves or any other similar equipment both from control room and local areas.
- (c) The system shall be designed based on the philosophy of command to energise a relay or solenoid valve.
- (d) Where there is more than one pump or fan for the same service (say 2 pumps), auto standby features shall be provided to select the standby unit and this standby unit shall start automatically on failure of running pump or on applicable process criteria (say low discharge pressure) with an annunciation.
- (e) All the contacts of the sensors used in protection circuit shall be monitored.
- (f) Triple redundant sensors shall be provided when used in protection circuits for major critical equipment and 2 out of 3 logic shall be derived for further use in protection circuit

4.02.06.3 Features-Interlock Requirements

- (a) Permissive conditions for a equipment start shall be provided. The permissive conditions within the equipment are bearing temperature normal, winding temperature normal, adequate suction pressure, bearing vibrations normal, bearing lubrication oil pressure normal, switchgear in service, switchgear not in test, no protection trip command persisting (as applicable) etc.
- (b) The permissive conditions from a process system related equipment are

establishment of free path for the flowing medium under all start-up, emergency and shutdown conditions, closure of discharge valve for the starting of first of the identical pumps/fans and then opening the valve after the operating condition is established etc.

- (c) Selection of standby equipment and starting the equipment automatically on the tripping of running equipment and/or desired process parameter conditions (say loss of discharge pressure or low level in the discharge tank etc.)
- (d) Isolation of the tripped equipment from the main process.
- (e) Any other conditions for safe starting and shutting down the equipment.

4.02.06.4 Features-Sequence Control Requirements

Sequence control shall be provided to start and stop the equipment and the associated auxiliaries. The sequence control shall have the following features:

- (a) Once the start-up or shutdown of an equipment is initiated either manually or automatically from the system, the control of associated auxiliaries shall be automatic with facility for manual operation at each stage (step).
- (b) Criteria check up for each stage of operation with monitoring and displaying.
- (c) Bypass facility for each criteria when only the feedback signal/display is incorrect but the actual condition is fulfilled. This activity shall be logged and annunciated in control system (DCS / PLC).
- (d) Adequate time delay between the steps as dictated by the process to establish an operating parameter or healthiness of an equipment.
- (e) Normally, the auxiliaries of the standby equipment should be running (as applicable) so that the standby equipment is started without loss of time.

4.02.06.5 Features-Protection Control Requirements

The following minimum protection shall be provided for the various equipment/system as applicable to trip the equipment.

- (a) Any condition which endangers the safety of the plant personnel
- (b) Any of the permissive conditions becoming abnormal thereby producing a dangerous condition in operating the equipment.
- (c) The conditions from process such as dry flow conditions, flashing conditions or any other conditions that may create cavitation.

4.02.06.6 Redundancy criteria of sensors for OLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.

4.02.06.7 Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.07 **System Architecture for Main Plant Control System (unit wise)**

Following Operating work stations & Engineering work stations per unit except wherever specifically asked for both unit, are envisaged for control & operation of main power plant from Unified Distributed Digital Control, Monitoring and Information System (DDCMIS) (Refer System Configuration Drawing, # 114-01-0100).

4.02.07.01 **Option 1 – For Unified DDCMIS**

4.02.07.01.01 **Operating Work stations:-**

- i. 6 nos of Operating Stations (one no. of boiler control system like MFT, two nos., for BMS (FSSS), Boiler auxiliaries, two nos. for Turbine auxiliaries and one no. for electrical system & BOP) shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 2 LJP A4 B/W and 1 LJP A4 Color.
- ii. 2 nos. of Operating Stations for Turbine Control System (governing system), like DEHGC, ATRS, ATT, ETS from the respective system shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 1 LJP A4 B/W & 1 LJP A4 Color.
- iii. 1 no. of Operating Station for TSE for Unit incharge (shift supervisor) with 1 LJP A4 Color (if this is not integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).
- iv. 1 no. of Operating Station for Unit incharge (shift supervisor) - Printer not required
- v. 1 no. of Operating Station for Station incharge (in the cadre of Executive Engineer) with 1 LJP A4 B/W.
- vi. 1 no of Operating Station for performance calculations & optimization for Unit incharge (shift supervisor) shall be provided with 1 LJP A4 B/W.
- vii. 1 no. of Operating Station for performance calculations & optimization at the Office of Executive Engineer/Efficiency shall be provided with 1 LJP A3 B/W.
- viii. 1 no. of Operating Station for water chemistry parameters connected with performance calculations & optimization at the SWAS / Chemical Express lab shall be provided with 1 LJP A4 B/W.
- ix. 1 no. common Operating Stations at Factory manager, and 1 no. common Operating Stations at Electrical System incharge room shall be provided for both units, operation/ command shall not be executed from these three consoles to start/stop the equipments. Software and hardware security lock shall be provided not to use these controls for any operations. 1 LJP A4 Color with each Operating station shall be provided.

- x. 2 nos. of common Operating Stations for both units at common DDCMIS network in CCR with A3 sized color LJP.

4.02.07.01.02 Engineering Work stations & Servers:-

- i. 2 nos. of Engineering Stations for system maintenance Engineer for unit DDC MIS system with 2 LJP A4 Color, 1 No. A3 sized Scanner, copier cum printer, 1 LJP Heavy Duty Industrial grade A3 Color.
- ii. 1 no. Engineering Station for system maintenance Engineer for Turbine Control System with 1 LJP Heavy Duty Industrial grade A3 Color.
- iii. 1 no Engineering Station for Turbine Stress Evaluation with 1 LJP A4 Color (if this is not in integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).
- iv. 1 no. of Engineering Station for Sequential Event Recording with 1 no. A3 sized DMP
- v. Redundant Historian server (Historical Data Storage & Retrieval system) with Work station and 2 no. A3 sized DMP.
- vi. 1 no. redundant server system for performance calculation & optimization (PADO) with Engineering work Station and Heavy Duty Industrial grade A3 Color printer.
- vii. Redundant OPC server for OPC connections with DDCMIS from other systems with Work station & 1 LJP A4 B/W.
- viii. Redundant MIS server with one no. MIS work station, and 1 no. LJP A4 B/W.
- ix. Common Redundant OPC server for OPC connections with both units DDCMIS from other common systems with Work station & 1 LJP A4 B/W.

4.02.07.01.03 "The local operating stations 6 nos. per unit namely at locations like ESP, Zero M Elev. Turbine building, Boiler - A Elevation, HT Switchgear room, SWAS / Chemical Express lab room & CWPH (with 1 no. A4 sized B/W LJP) and 1 nos. namely at common locations like FOPH shall be provided with 24" LED color screen/OWS, with minimum configuration connected to DDCMIS on redundant connection to show the status/conditions of various process parameters/equipments in process mimics, trends, logs etc with real time data.

Operation/command shall not be executed from these local operators' consoles to start/stop the equipments. Software and Hardware security lock shall be provided for not using these consoles for any control/operations. Specification of these local stations shall be same as specified at cl. no. 4.03.03.04 respectively.

All the locations/rooms availing the operating stations namely FOPH, CWPH, Boiler A elevation, Turbine 0 meter, ESP, Ash handling Control room, HT Switchgear room, 400 KV switchyard control room and SWAS / Chemical Express lab, DM Plant are to be air conditioned.

4.02.07.01.04 All operating stations connected on redundant data highway shall be interchangeable and operation of the plant shall be possible from Engg. station after security check. All operator stations shall have full access to the entire plant database and shall have identical functionalities. The system shall have full database redundancy. The database shall be independent and shall reside separate from the operator stations.

4.02.07.02 Option – 2

- i. Separate DCS based control system is provided for Turbine integral control and DEHGC, ATT, same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii) and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.
- ii. Separate DCS based control system is provided for Turbine protection (ETS – Emergency trip system), same shall be provided with one no. operating station and one no. operating cum engineering station and one no. A4 sized B/W LJP.
- iii. Separate DCS based control system is provided for MFT & Boiler protection controls, same shall be provided with one no. operating station, one no. operating cum engineering station and one no. A4 sized B/W LJP and one no. A4 sized color LJP.
- iv. For option 2, Quantities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03 irrespective of separate control systems (DCS) for Boiler integral controls and Turbine integral control respectively.
- v. In case bidder provide separate Turbine control system & Boiler control system from DDCMIS. Then configuration of LVS shall be 4 no. LVS with Display controller as part of DDCMIS package, 1 no. LVS with display controller as part of Turbine control system and 1 no. LVS with display controller as part of Boiler MFT control system.

4.02.07.03 Option – 3

- i. Separate DCS based control system is provided for DEHGC, TSC, ATT & Turbine protection (ETS – Emergency trip system), same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii), one no. OWS for ETS/Turbine protection, and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.
- ii. MFT & Boiler protection controls shall be part of DDCMIS.
- iii. For option 3, Quantities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03, irrespective of separate control systems (DCS) for Turbine integral control system.

- iv. In case bidder provide separate Turbine control system from DDCMIS. Then configuration of LVS shall be 5 no. LVS with Display controller as part of DDCMIS package and 1 no. LVS with display controller as part of Turbine control system.

4.02.07.04 Total 6 No. 80/84" diagonal sized LVS per unit shall also be provided for monitoring, operation and control of power plant as per details specified elsewhere in the specification.

2 no. common 80/84" diagonal sized **LVS** with their own display controller connected to both unit DDCMIS on common redundant OPC network to show the status/ conditions of various process parameters/equipments in process mimics, trends, logs etc of common BOP/Offsite packages with real time data shall be provided by bidder. These two nos, LVS are common to both 2 X 660 MW units and shall be located in CCR. Operation/command shall not be executed from these LVS to start/stop the equipments. Software and Hardware security lock shall be provided for not using these local LVS for any control/operations.

4.02.07.05 Modulating Controls (CLCS) and Discrete Open Loop Control (OLCS) shall be designed to eliminate the necessity of operator action except manual / auto selection, set point changes, biasing and similar actions during normal operation. Bumpless and balance less transfers between automatic and manual operation modes and vice-versa shall be provided automatically without need of operator action. Complete backup shall also be provided for safe shutdown operation of plant.

The system shall have built in redundancies for all system functions both at the processor and device level. No failure of any single device or processor shall lead to any system function being lost. It shall have redundant data highway on a "master less" principle.

Redundant equipment wherever provided shall be powered from redundant power supply units in order to improve system availability and reliability.

The system shall have the capability and facility for expansion through addition of station/drops, controllers, processors, process I/O cards etc., while the existing system is fully operational. The system shall have the capability to add any new control loop in CLCS and new group, sub group, drive functions in OLCS while existing system is fully operational. Intelligent I/O cards will be preferred.

All the basic systems shall be connected through redundant data highway/bus system. The local bus system with associated bus couplers shall be provided for communication between different I/O modules and processors. The communication system shall be designed keeping in view the integrity & security aspects for the control system. In case the system employs master communication controllers, facility for 100 % hot back up controllers with automatic switch over shall be provided and it shall be ensured that no loss of data takes place during failure of communication controller.

The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, black out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.

The application programmes for the functional controllers shall reside in EPROMS or in non volatile RAMS. The application programme shall be alterable by access through programmer's console. Parts replacement or parts removal shall not be required for accomplishing changes in application programmes including control loop tuning. Each controller shall be equipped with the amount of functional capacity required to perform its specified functions and still have an overall spare capacity of 40%.

4.02.08 Redundancy & Availability Requirements

The CPU / Controllers, communication modules, data highway, power supply modules, etc for all DDCMIS/DCS/PLC shall be 100% hot standby redundant. I/O cards redundancy shall be as per cl. No. 4.02.08.02.

4.02.08.01 Controller Redundancy

All functional controllers for sequence control, functional controllers for closed loop control and functional controller for DAS & monitoring shall be provided with hundred percent hot standby controllers. However controller redundancy is not mandatory, where controller is purely executing data acquisition & monitoring functions. DAS function can also be integrated within CLCS/OLCS controller. All processors for modulating controls shall have self-tuning facility.

All the 100% hot back up controllers shall be identical in hardware and software to their corresponding main controllers. Further, each of the 100% hot back up controller shall be able to perform all the tasks of their corresponding main controller. The 100% hot back up controller shall continuously track/update its data corresponding to its main controller. There shall be an automatic and bumpless switchover from the main controller to its corresponding back-up controller in case of main controller failure and vice versa. The changeover shall take place within 50 msec. Engineered solution for redundancy in CPU are not acceptable. Dual redundant controllers shall be placed separately and shall not share the same motherboard or shall not have any other common sharing point.

Any switchover from main controller to 100 % hot back up controller and vice versa, whether automatic or manual shall not result in any process upset or any change in control status. The transfer from main controller to the back-up & vice-versa shall be indicated as alarm on all operator station OSs.

In case of switchover from main controller to back up controller, the back-up controller shall be designated as the main controller.

All the input variables shall be available to the main controller as well as its 100% hot back up controller so that any failure within the main controller shall not degrade the input data being used by the 100% hot back-up controller and vice-versa.

Each controller shall have 40% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops under worst load conditions. Each controller shall have battery backup or EEPROM/NVRAM for program memory.

Parts replacement or parts removal shall not be required for accomplishing changes in application programmes including control loop tuning.