e) Sub vendor list for motors (Annexure-IV)
f) Technical specification for LT switchgear
g) Technical specification for motors
h) Technical specification for LV cables
i) Technical specification for cabling
j) Technical specification for earthing & lighting protection

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : MRS

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 2X800 MW UPPUR STPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor. Starter for single phase motor (if applicable) shall be in vendor's scope. BHEL shall provide only single phase supply feeder.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : MRS

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 2X800 MW UPPUR STPP

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : MRS

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 2X800 MW UPPUR STPP

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

SECTION – 11 : 415V SWITCHGEARS AND DC BOARDS

11.01.00 SCOPE

11.01.01 This specification is intended to cover design, engineering, manufacture, assembly, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of following with all fittings and accessories for efficient & trouble free operation:-

i) 415 V Power control Centre (PCC)
ii) 415 V Motor Control Centers (MCC)
iii) 415 V Motor cum Power control Centre (PMCC)
iv) 415 V Distribution Boards (DB) and Fuse boards
v) DC starters
vi) DC Distribution Board
vii) AC Fuse Board

11.01.02 Base channel frame of all boards and fuse boards along with necessary mounting hardware.

11.01.03 Set of accessories as listed below:
i) Hydraulic operated Breaker lifting & handling trolley- 1No. per board
ii) Racking in/out handle for breakers- 5 Nos. in each type per board
iii) Racking in/out handle for draw out MCC modules- 5 Nos. in each type per board

11.01.04 Bidder to ensure that at least 10% spare feeders (minimum 1 No.) of each type & rating in each 415V switchgear/MCC shall be provided at the time of handing over the plant (irrespective of the spares finalised during detailed engineering) subject to the contract provision.

11.01.05 Mandatory Spares as given in elsewhere

11.01.06 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates cable supports, crimp type tinned copper/aluminum lugs, double compression type brass glands with tapered washer (power cables only) and terminal blocks.

11.01.07 Foundation bolts for all the floor mounted equipment, and fixing bolts and accessories for wall mounted equipment.

11.01.08 All interconnecting wiring between various panels/compartments of a switchgear or MCC shall be carried out internally by the Bidder at his works/site.

11.01.09 Certain switchgears with very long lengths shall be sectionalized and physically separated for ease of operation and maintenance. Interconnection of such sections by bus trunking shall be in Bidder's scope.

11.01.10 Bidder shall supply dummy panels, if required for floor beam crossing without any price implication.

11.01.11 All 415V PCC, PMCC & MCC shall generally be of intelligent type compatible with IEC 61850 Communication protocol. However utility MCCs as mentioned in the single line diagram shall be non-intelligent type. . A marshalling module shall be provided on each bus of LV Switchgear (PCC, PMCC, MCC) for interfacing with DCS. Control of incomers and bus-coupler breakers of LV switchgear shall be possible from the DCS. The check synchronizing relay shall be housed in the respective switchboards. Dummy panels shall be integral part of the LV Switchgear and of same size.

11.01.12 MCCs shall be used to supply power to contactor controlled motors rated below 90 kW, local panels, local starter panels etc.

11.01.13 PCCs / PMCCs shall be used to supply power to motor of ratings 90 to 200 KW through ACBs.

11.01.14 Incomers of MCCs of rating 630A and above shall be through Air Circuit Breakers while incomers of lower rating can be through motorized MCCBs.

11.01.15 All Outgoing feeders (non motor feeders) of PCC/PMCC rated 630A & above shall be Air Circuit Breakers while rated below 630A shall be MCCB.

11.01.16 Motors less than 90 KW shall be provided with MCCB/ MPCB, contactors and intelligent controllers.

11.01.17 Motors rated 90 KW and above shall have comprehensive motor protection relays. They shall be numerical type and shall communicate with DCS through Open protocol (IEC 61850).

11.01.18 All MCCs/PMCCs except PCC portion of PMCC shall be of double front construction. PCCs and PCC portion of PMCCs shall be single front. All Switchgears/MCCs shall be sectionalized unless specifically mentioned in the single line diagram.

11.01.19 All Switchgears shall be easily extendable on either side. The Bidder shall supply Switchgear in various shipping sections consisting of Incomer, Ties and Motor modules. Bidder may be required to change module types, sizes and the components in respect of certain feeders even during erection, testing and commissioning.

11.01.20 The Bidder shall furnish calculations and/or type-test certificates to prove adequacy of the bus bar sizes offered, for specified current and short time current ratings. Bus bars in particular and droppers (HBB/VBB) shall be supported on flame-retardant, track resistant type bus insulators with high creepage distance and covered with heat-shrunk PVC sleeves which shall be shrunk fit and not capable of being removed without destruction. While continuous current ratings of the droppers in each Switchgear Cubicle shall be at least equal to the corresponding Breaker rating, short time current rating shall be same as that for Horizontal Main Bus bars. Only those dropper ratings shall be allowed as have passed a type test.

11.01.21 All MCCB, MPCB and contactors shall conform to Type-II class of Co-ordination as per IS-13947. Bidder shall furnish Type-II Co-ordination, p & q type test report as per IS: 13947 for all modules.

11.01.22 The Bidder shall furnish relay application checks/ calculations to check adequacy of the CTs/VTs as well as suitability of relay settings/setting ranges proposed by the Bidder. These checks/ calculations shall be furnished during detailed engineering stage for each and every feeder.

11.02.00 AUTO CHANGEOVER

11.02.01 Auto-changeover facility shall be provided in PCC/ PMCC and MCCs. These Switchgears/MCC shall normally operate with Bus coupler open. If sustained under voltage is detected on any one of the bus section, the respective Incoming Breaker shall trip and bus - coupler shall close if voltage is available on the other bus section. Auto changeover shall be blocked if the Incoming Breaker has tripped due to bus fault. Manual change over from one source of supply to the other or vice versa shall be possible by momentary paralleling of the two supplies after checking synchronism with the help of a synchro check relay. On closing the Incoming breaker, the selected running Breaker should trip within a preset time. An annunciation shall be provided if the two bus sections remains paralleled for more than a preset time. If the selected running breaker fails to trip within the preset time the incoming breaker shall trip.

11.02.02 During auto changeover of the supply the contactors in the affected bus would have dropped off. The services which shall be restarted immediately without time lapse to keep the process running are considered essential services. Such services shall restart automatically without any action by the operator after an auto changeover.

11.03.00 GENERAL

11.03.01 Power Control Center (PCC)

POWER CONTROL CENTER (PCC), shall mean a continuous line-up of breaker panels in single front construction, used to feed Motor Control Centres/PDBs etc, ACB controlled LV motors. All PCCs shall have duplicate incomers and a bus-section. Incomers, bus section, and all outgoing feeder of a PCC shall be breaker controlled. Distribution of outgoing feeders shall be arranged such as to ensure uniform loading on each section of the PCC. The 240 V supply for panel & Motors Space Heater, wherever required shall be derived through 415V/240V isolation transformer.

11.03.02 Power-Cum-Motor Control Center

POWER-CUM-MOTOR CONTROL CENTER (PMCC), shall mean a continuous line-up of vertical sections housing breaker panels, MCCBs, and contactor-operated modules in double front construction. However PCC part of PMCC shall be single front only. All PMCCs shall have duplicate incomers and a bus-coupler. Incomers and bus-coupler shall be breaker controlled. All outgoing (non motor) feeders shall be ACB/MCCB/MPCB controlled. Motor feeders rated below 90 kW shall be MPCB, MCCB, contactor controlled with intelligent controllers depending upon the rating Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PMCC. The 240 V

supply for panel & Motors Space Heater, wherever required shall be derived through 415V/240V isolation transformer.

11.03.03 Motor Control Center

MOTOR CONTROL CENTRE (MCC), shall mean a continuous line-up of vertical sections in double front construction, housing breaker panels and MPCB / MCCB, contactor operated outgoing modules. All incomers and Bus-sections rated 630A & above shall be breaker controlled which are electrically inter-locked. MCCBs shall be provided for incomers and bus couplers rating below 600A with castle key interlocks. All outgoing (non motor) feeders shall be MCCB/MPCB controlled. Motor feeders shall be MPCB, MCCB, contactor controlled with intelligent controllers depending upon the rating. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the MCC. The 240 V supply for panel & Motors Space Heater, wherever required shall be derived through 415V/240V isolation transformer.

11.03.04 Distribution Board

Distribution Board (DB) shall mean a continuous line-up of vertical sections housing MCCB/MPCB modules only. PDBs/ACDBs shall have duplicate incomers and a bus-section. DCDBs shall have two incomers from its associated battery charger with bus sectionalized. Wherever bus-sections are provided, distribution of outgoing feeders shall be such as to ensure uniform loading on each section of DB.

11.04.00 CODES AND STANDARDS

11.04.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard (IS) except where modified and / or supplemented by this specification. Indian Standards for the equipment covered under this specification are as follows:

IS:375	Marking and arrangements of bus bars.
IS:722	AC Electricity Meters.
IS:1248	Electrical Indicating instruments.
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear.
IS:2208 & IS:9224 (Part-II)}	HRC Cartridge Fuses.
IS:2516	A.C. Circuit Breakers.
IS:2629	Hot dip galvanising.
IS:2705	Current transformers
IS:2959	Contactors

IS:3072	Code of practice for installation and maintenance of Switchgear.
IS:3156	Voltage transformers
IS:3202	Code of practice for climate proofing of electrical equipment.
IS:3231	Electrical relays for power system protection.
IS:4064	Air-breaker switches, air break disconnectors, air break disconnector and fuse combination units for voltage not exceeding 1000V AC or 1200V DC.
IS:4237	General requirements for switchgear and control gear for voltages not exceeding 1000V.
IS:5082	Wrought Aluminum and aluminum alloys for electrical purposes.
IS:6005	Code of practice of phosphating iron and steel.
IS:6875	Switches and push buttons.
IS:8544	A.C. Motor starters of voltage not exceeding 1000 V.
IS:8623	Specification for factory built assemblies of switchgear & control gear for voltages up to and including 1000V AC/1200 V DC.
IS:13947	Low voltage switchgear and Control Gear.

11.04.02 Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such cases copies of the English version of the standard adopted shall be submitted along with the bid.

11.04.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS codes of practice. In addition, other rules or regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

11.05.00 DESIGN CRITERIA

11.05.01 The PCC/PMCC/MCC and DBs shall be used to supply auxiliary power for normal and start-up operation, control and protection for 415/240V AC and 220V DC auxiliary services of generating units.

11.05.02 Duty involves direct-on-line starting of large induction motors up to 200 KW and also under certain emergency conditions automatic transfer of loads from one source of supply to other. Motor starting current varies from 6 to 8 times full load current with maximum of 3 starts per hour.

11.05.03 The equipment shall be located in a clean but hot, humid and tropical atmosphere, highly polluted at places with coal dust and/ or fly ash.

11.05.04 Circuit breaker/ switchgear shall not produce any harmful over voltage during switching off induction motors/ supply. If required, surge protective devices shall be included in the scope of supply to limit over voltage.

11.05.05 For continuous operation at specified ratings, the temperature rise of the various equipment shall be limited to the site permissible values stipulated in this specification.

11.05.06 Loads of outgoing feeders wherever applicable shall also be considered while sizing the bus bars, equipments and components. All equipment and components shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents without any damage or deterioration of materials.

11.05.07 Busbars for PCC/PMCCs being fed from service transformers shall be sized based on the rated LV winding current of the transformer rounded off to the next higher standard rating

11.05.08 Busbars of MCCs/DBs shall be sized to carry continuously the running load connected to it with a 10% margin.

11.05.09 In cubicle ratings of incomer and bus section breakers/MCCBs shall be identical to the associated busbar rating.

11.05.10 The control circuitry of all modules in respective PCC/PMCC/MCC shall be suitable for interfacing with plant DCS for remote monitoring switching and control.

11.06.00 SPECIFIC REQUIREMENTS

11.06.01 Construction of PCC/PMCC / MCC/ DBs

i) The PCC/PMCC/MCC shall be of Form 3B Type 2 construction.

ii) PCC/PMCC/MCC/DBs shall be indoor, air insulated, metal-clad, floor mounting type. All PCCs/PMCCs/MCCs except for the utility MCCs shall be fully draw out type having self-aligning type secondary plug in contacts. All DBs and utility MCCs (as mentioned in single line diagram) shall be fixed type. The design and construction shall be such as to allow extension at either end.

iii) The enclosure of the equipment shall be dust and weather proof, conforming to a degree of protection IP-52 for ratings up to 1600A and IP-42 for ratings above 1600A. The switchboard frames shall be fabricated using suitable mild steel structural section or braced and shall be cold rolled sheet steel of thickness of not less than 2 mm. The frames shall be enclosed in cold rolled sheet steel of not less than 1.6 mm. The doors and covers shall also be of cold rolled steel of thickness not less than 1.6mm. Adequate stiffness shall be provided wherever necessary. Gland plates shall be 3 mm. The design shall be such that specified degree of protection shall be achieved even after a breaker control module has been taken out of the panel.

iv) SWGR/PCC/MCC/ DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multitier formation. The installations of circuit breakers, however, shall be limited to the single tier formation.

v) The design shall be fully compartmentalized with metal/ insulating partitions between compartments. The working height shall be limited within 300mm to 1900 mm. Switch boards shall be mounted on base frame of 75 mm height from the finished floor.

vi) Each breaker/ control module/ MCCB unit shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section of single front board shall have a removable back cover.

vii) All doors and covers shall be provided with life long rubber and life long pasting neoprene gaskets. MCC module shall also be dust and vermin proof when the module is taken out from the chassis. Suitable arrangement to achieve this feature shall be provided.

viii) All switches push buttons, lamps, indicating instruments shall be flush mounted on respective module compartment whereas relays and other auxiliary devices may be mounted on a separate cubicle. All meters indicating lamps and protective relays shall be visible on the door.

ix) A full height vertical cable alley with cable supports shall be provided in each section to facilitate dressing of unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have hinged doors opening on opposite sides with respect to the module doors and removable cover at back side for access. The width of the cable chamber when viewed from front of the switchboard shall not be less than 250 mm.

x) Breaker cubicle shall be so sized as to permit easy closing of the front access door when the breaker is pulled out to 'ISOLATED' position. The breaker can be operated both in SERVICE and TEST position with the door closed.

xi) A horizontal wire way, extending the entire length, shall be provided at the top of each SWGR/PCC/MCC/ DB for inter panel wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

xii) Incomers shall be provided at the ends of an assembly and bus section, wherever required, shall be provided at the middle of the assembly.

xiii) Four (4) nos. lifting lugs shall be provided for each section, two (2) nos. on either end of the section.

11.06.02 Bus and Bus Taps for SWGR/PCC/MCC/DB

i) The main, tap off buses and connections shall be of high conductivity aluminum / aluminum alloy . The size for specified current ratings shall be such that maximum temp. rise at bus bar joints shall be limited to 90 Deg. C (i.e. 40 Deg. C rise over 50 Deg. C ambient).The maximum allowable temperature rise at silver plated joints shall be 105 deg C (ie 55 deg C rise over 50 deg C ambient)

ii) Vertical bus bars shall be designed as per system requirement.

iii) All bus connections shall be provided with anti-oxide grease. For all bus connections adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and locknuts. The protruding bolts of different phases/ poles shall be staggered and shall not see each other directly. All the joints surfaces shall be silver plated.

iv) Busbars and connections shall be fully insulated for working voltage with adequate phases/ ground clearance. Insulating sleeves for bus bars and shrouds for joints shall be provided. Shrouds for bus bar joints and tapping points shall be two part click-fit type epoxy resin cast/ fiber glass moulded.

v) Minimum clearance of 25.4mm is required between phases/ poles for entire run of horizontal and vertical bus bars and 19 mm between phase and earth irrespective of sleeve/ shroud provided for bus bars.

vi) For all other components, the clearance between two live parts, a live part and earthed part, and isolating distance shall be at least 10 mm throughout.

vii) Wherever it is not possible to maintain the above mentioned clearances, insulation shall be provided by means of barriers. All connections from busbars upto the fuses shall be fully shrouded to minimize risk of phase to phase and phase to earth faults.

viii) Insulating shrouds for busbar joints shall be moulded type. SWGR/PCC/MCC/ DB with higher clearances shall be preferred considering dust laden environmental condition in which SWGR/PMCC/ MCC/ DB has to operate. Bus bars shall be supported on flame-retardant, track resistant type bus insulators with high creepage distance and covered with heat-shrunk PVC sleeves which shall be shrunk fit and not capable of being removed without destruction. Separate supports shall be provided for each phase and neutral busbar.

ix) Cross section of busbar shall be uniform throughout the length of assembly. All buses and connections shall be supported and braced to withstand, the stresses due to maximum short-circuit current and also to take care of any thermal expansion.

x) Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from the front of the SWGR/PMCC/ MCC/ DB assembly.

xi) Bolted disconnect links shall be provided for DBS for all incoming and outgoing feeders for isolation of neutral, if necessary.

11.06.03 Module Details

i) Draw out type control module shall have self- aligning, plug in power / control disconnects. All disconnects shall be silver-plated to ensure good contacts.

ii) The design shall be such as to permit easy withdrawal / reinsertion of the unit guide rails to ensure correct alignment & all the power contacts meet accurately every time the module is inserted. Two feeders shall not be accommodated in the same module of MCC.

iii) Various module sizes should be multiples of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical busbars.

iv) Control module shall house the control components for a circuit such as MPCB / MCCB, contactors, relays, push buttons, lamps etc. as per requirement only the push button actuators, lens of indicating lamps, and transparent windows for meters shall be mounted on module door such that when the module is withdrawn the cubicle door shall be provided the specified degree of protection when the module door is closed. These modules shall be designed to withstand internal arc faults i.e. in the event of fault occurring in one module the arc should not spread to neighboring module and should not affect their functioning.

v) The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.

vi) It shall be possible to carry out routine, maintenance checks or small changes in a module without physically taking the module away from switchboard.

vii) Automatic safety shutters shall be provided to fully cover the female primary disconnects when the module is withdrawn. Under any circumstances it shall not be possible to access the vertical dropper accidentally and also suitable means shall be provided to avoid any phase short circuit in vertical droppers.

viii) The module shall be dust & vermin proof even when module is completely withdrawn. Suitable means shall be provided to achieve this feature.

ix) Draw out type control modules of same size and type shall be electrically and physically interchangeable.

x) Draw out control modules of PCC/PMCC/MCC shall have the SERVICE, TEST & ISOLATED positions with positive indications and interlocking for each position. The doors of individual modules and the cable alley should open in opposite directions to facilitate clear view of the module when the operator is working on the cable terminals.

xi) In service position, both power and control circuits shall be engaged. It shall not be possible to open the module door when the module is in service position.

xii) In TEST position, the power circuits shall be disengaged but the control circuits shall be engaged. It shall be possible to close the module door when the module is in TEST position. Keeping the front access door of module in closed condition, the breaker can be placed in ISOLATED, TEST or SERVICE position from outside.

xiii) In ISOLATED position, both power and control circuits shall be disengaged.

xiv) For motors 90 KW and above, ACBs with numerical protection relays are envisaged. All motor feeder modules shall also be provided with local/ remote selector switches on the module itself.

11.06.04 Circuit Breakers

i) Breakers shall have anti-pumping feature.

ii) Circuit breakers shall have minimum interrupting capacity equal to the listed fault level.

iii) Circuit breaker shall be three poles air break type with stored energy, trip free mechanism and shunt trip.

iv) Circuit breakers shall be draw out type, having SERVICE, TEST & ISOLATED positions with positive indication for each position.

v) Circuit breakers of identical rating shall be physically and electrically interchangeable.

vi) All circuit breakers shall be of motor wound spring charged mechanism and also shall have hand operated spring charged mechanism facility.

vii) For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close/ open operation of the circuit breaker shall be possible after failure of power supply to the motor.

viii) Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed.

ix) Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.

x) Each breaker shall be provided with closing and emergency manual trip, mechanical ON-OFF indicator, an operation counter and mechanism charge/ discharge indicator.

xi) In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with following for interlocking purpose:-

a) Position/ cell switch with 4 NO + 4 NC contacts.

b) Auxiliary switch, with 6 NO + 6 NC contacts, mounted on the moving portion of the switchgear/ PMCC/ MCC and operated mechanically by a sliding lever from the breaker

c) Alternatively. Electrically reset latching relay may be used for the purpose. The exact requirement of contacts of position/cells switch, limit switch, auxiliary switch and latching relay shall be decided by the Bidder taking into account the scheme requirement spares.

d) Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches for motor duty shall be provided with minimum 2 NO + 2 NC aux. contacts.

e) Limit / auxiliary switches shall be convertible type that is suitable for changing N.O contact to N.C. and vice-versa.

xii) Provision of mechanical closing of breaker only in 'Test' and 'Widrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. It shall be possible to close the door with breaker in test position.

xiii) Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control switches for other circuits.

11.06.05 Moulded Case Circuit Breakers (MCCB), Motor Protection Circuit Breaker (MPCB) and Miniature Circuit Breakers (MCB)

i) MCCBs shall be provided with spring assisted quick make/break manually operated trip free mechanism.

ii) MCCBs / MPCBs shall be provided with adjustable tripping device with inverse time characteristics for overload protection and instantaneous characteristics for short circuit protection. As per requirement, MCCBs shall also be provided with ground fault protection and 1NO contacts for tripping indication / alarm for Owner use.

iii) MCCBs / MPCBs for motor feeder shall be equipped with instantaneous magnetic adjustable tripping element only.

iv) MCCBs operating handle 'ON' and 'OFF' positions shall be displayed and the operating handle shall be mounted on the door of compartment/module housing MCCBs.

v) MCCBs/MPCBs shall be provided with minimum 2 NO + 2 NC spare auxiliary contacts

vi) MCBs shall be used in all the AC control circuits and DC control & lighting feeders, as specified. However, control fuses may be used in the ACB feeders for DC circuit.

vii) The MCBs shall be suitable for manual closing and opening and automatic tripping under overload and short circuit conditions. They shall be provided with trip-free mechanism.

viii) The MCBs shall be suitable for housing in the lighting panels and for connection of standard copper / aluminium wires at both the incoming and outgoing ends by copper lugs or bus bars connection on the incoming end.

ix) The terminals of MCB and ON and OFF positions shall be clearly and indelibly marked.

x) The interrupting current and continuous current rating of the MCCBs shall be as per the requirement.

11.06.06 Contactors

i) The contactors shall be three pole, air break type designed for duty class III category A.C. –3 for non-reversing and AC4 for reversing starters with non-bouncing silver / silver alloy contacts.

ii) Each contactor shall be provided with two (2) normally open and two (2) normally closed auxiliary contacts. Reversing contacts shall be electrically and mechanically interlocked.

iii) Contactors with delayed dropout feature shall be provided for some essential auxiliaries. These contactors shall not dropout on power failure if the voltage is restored within 3 seconds.

iv) Contactors shall break without damage 10 times rated current up to 100 amp rating and 8 times rated current for above 100 amp rating.

v) Coil continuous current shall not exceed 2 amp and initial pick up shall be limited to 9 amp. Class of insulation shall be E or better.

vi) Drop out voltage shall be 45 to 65% of rated voltage and pick up shall be 85 to 110%. Contactor duty shall be as per requirement.

vii) Coil shall be designed for the control voltage without economy resistors.

11.06.07 A.C. Starter

A.C starters shall be of TYPE II coordination.

11.06.08 DC Starter

i) DC starters shall be complete with switch fuse units, contactors, resistors, relays, meters, push buttons, lamps, etc.

ii) Starters shall be furnished in totally enclosed floor mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2 mm.

iii) The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP 54.

iv) The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP 23.

v) Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with SFU and thermostat control.

11.06.09 Power Distribution board (PDB)

i) PDB shall house MCCB modules only with have duplicate incomers and a bus-coupler. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of DB. Board shall be single/double front, metal clad, front matched, dust and vermin proof, fixed type compartmentalized and extensible on both sides with IP51 type enclosure.

ii) Shall have base channel of size ISMC 75.

iii) Shall have isolated busbar chamber for main bus bar at the top, running throughout the length of the board. Chamber shall have removable cover.

iv) Cable alley shall have sufficient space for aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical bus bar.

v) Bus bars shall have same cross section throughout the length. Rating of the neutral bus bar shall be 50% of the main bus bar. Earth bus bar shall run in bottom chamber throughout the length of the panel.

vi) Isolation transformer shall be provided in the PDB for driving 3 Ph, 4 Wire supply.

11.06.10 DC Distribution Boards

DCDBs shall have two incomers and a bus coupler. Incomers and outgoing feeders of DCDBs shall be switch fuse modules/MCCB modules. They shall be fixed type and floor mounted. Other constructional features shall be similar to PDB.

The feeder rating and quantity shall be as per requirement.

11.06.11 AC Fuse Boards

AC Fuse Boards, shall have switch fuse units as incomer. Fuse boards may be fed from DBs and shall have two incomer. AC fuse boards shall be of two types - one with 415V, 4-wire, triple pole- and-neutral (TPN) outgoing feeders and the other with 240V, 2- wire, single-pole-and-neutral outgoing feeders. The boards shall be wall mounted type and other constructional features as given in above specification for PDB except that fixed type module are accepted for such DBs.

For small loads, MCB boards with TPN MCB as incomer and TPN/SP MCBs for outgoing may be considered. However, to bring down the short circuit level to safe limits, isolation transformer shall be provided wherever necessary.

The feeder rating and quantity shall be as per requirement.

11.06.12 Control & Indication

i) The circuit breaker shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with following:-

a) One (1) “TESTREMOTE” selector switch stay put type with black pistol grip handle and key interlock for motor feeder breaker and as well as for incoming and outgoing tie feeders.

b) Two (2) heavy duty, oil tight, push buttons for TRIP & CLOSE.

c) One (1) heavy duty, oil-tight, CLOSE-NEUTRAL-TRIP Switch

d) Indicating light on front of compartment:

GREEN	-	Breaker open
RED	-	Breaker closed
AMBER	-	Trip/Trip circuit trouble
BLUE	-	Breaker Spring charged
AMBER	-	Breaker, Auto trip
WHITE	-	Trip coil healthy
WHITE	-	Breaker in test position
YELLOW	-	Breaker in service position

e) Lamps shall be LED type with coloured dome. Lamps and lens shall be replaceable from the front. LED lamp shall be made in accordance with InP technology (Aluminuim Indium Gallium

Phosphide technology). The body shall be made of poly carbonate unbreakable lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All push button lamp shall be as per LED indicating lamp.

f) Two(2) incomers and bus coupler shall be so interlocked that no two incomers shall operate in parallel except during momentarily paralleling.

ii) The control module shall be connected for local remote operation. Each control module shall be equipped with the following:

iii) Required nos. of push buttons as per scheme drawing.

iv) Each push button shall have two (2) normally open and two (2) normally closed contact rated 10A at 240V.

v) Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.

vi) One (1) MCC-REMOTE selector switch having make before break feature shall be provided for unidirectional motor feeders.

vii) For Test control supply, the Bidder shall provide separate 415/110 control transformer.

viii) DCDBs shall be provided with indication to monitor healthiness of the incoming DC supplies.

11.06.13 Current Transformer

i) Current Transformers shall be epoxy cast-resin type rated minimum of 10 VA. All secondary connections shall be brought out to terminal blocks where wye or delta connection shall be made. Insulation class shall be “E or better.”

ii) Accuracy class of the current transformers shall be:-

a) Class PS for differential
b) Class 5P20 for other relaying
c) Class 1.0, ISF < 5 for metering other than MEAA
d) CTs for MEAA metering shall be as per Chapter-1

iii) Separate wire shall be used for metering and protection as far as possible. Secondary wire terminals shall be made available accordingly.

iv) Terminals with CT secondary shorting links for metering leads and TEST terminals block for C.T. secondary relay and KWH leads shall be provided.

v) VA Burden of CT's shall be adequate (15 VA minimum) for connection to remote metering system. Also additional terminal blocks etc. as may be required shall be provided in panels.

vi) CT secondary shall be rated 1 A for metering and protection.

11.06.14 Voltage Transformer

i) Three nos. single phase voltage transformer shall be provided in each incoming power supply circuit with voltmeter and selector switch. Additional three nos. voltage transformers shall be provided for each bus section voltmeter and its selector switch. These voltage transformers shall be mounted in separate compartments of the switchgears.

ii) Voltage transformers shall be epoxy cast resin and shall have an accuracy class of 1.0. Voltage Transformers mounted on breaker carriage is not acceptable. Voltage rating for the Transformer shall be 1.2 continuous and 1.5 for 30 second.

iii) Voltage transformer shall capable to withstand 200% of rated voltage continuously without change in its characteristics.

iv) High voltage windings of voltage transformer shall be protected by current limiting fuses.

v) Suitably rated three phase MCBs to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy access while the MCC is energised.

vi) VTs for MEAA metering shall be as per Chapter-1

11.06.15 TEST Control Transformers

i) For TEST control supply control transformers of adequate rating (min. 2 KVA rating) shall be provided.

ii) For motor space heating supply, the transformers of adequate rating (min. 2 KVA rating) with 100% standby shall be provided.

iii) All the control transformers shall be placed in spacious compartments to have proper air circulation and keep lower temperature of transformer and its module.

iv) All the control transformers shall be provided with selector switch, fuses, indicating lamps. Each control transformer shall feed to its control buses of respective bus section during normal operation. In case of failure of one of the control transformer, provision shall be made to tap the control supplies from other bus section control transformer by auto changeover using aux. relays contacts/switch. Bidder has to develop scheme accordingly. This logic shall be made applicable for space heating and winding heating control transformer also.

v) All control transformer shall conform to IS: 12021.

vi) Control transformer shall have OCTC tap range of ± 5% in steps of 2.5% per tap.

11.06.16 Control supply for MCC modules

i) Each motor feeder of MCC shall be provided with suitably rated 415/110V control transformer, for arranging control supply for the module. All the necessary auxiliary and main contactors shall be provided suitable for this control supply.

ii) In test position module control supply shall be disconnected and provision shall be available to test the control circuit through test bus, obtained from separate control transformer provided for this purpose.

11.06.17 Control supply for ACBs of PCC and PMCC modules

i) Two 220 V DC feeders shall be provided in each board for power supply of control, shunt tripping and annunciation purpose.

ii) Control supply shall have supervision facility, alarm shall be provided for non-availability of any one of the control supply.

iii) MCCBs/MCBs shall be provided on incoming sides of supplies. Control buses of two sections shall be connected through auto changeover scheme.

iv) LEDs shall be provided for the indication purpose.

v) Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing / Tripping circuits of each cubicle

11.06.18 Relays

i) Relays shall be of draw out design with built-in testing facilities. Small auxiliary relays may be in non-draw-out execution and mounted within the cubicle.

ii) Numerical type protective relays shall be provided to isolate the faulty equipment and system as early and as expeditiously possible.

iii) The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock and bus transfer scheme as broadly indicated in the drawings.

iv) All relays shall be mounted on the front of the panel and shall be specified as per requirement.

v) Protection relay shall be lockout type with hand reset feature.

vi) Rated continuous making and breaking currents for contacts shall be suitable for service involved.

vii) All Relays shall be suitable for 220 V DC operation.

viii) All numerical relays shall have keypad / keys to allow relay settings from relay front. In addition, relay shall have front port for downloading / uploading of relay settings from the PC / Laptop. All hand-reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable.

ix) All relays shall have LED / LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65^0C for contrast and legibility.

x) As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on.

xi) The relay shall have at least 6 programmable LEDs on relay front.

xii) Software Security

xiii) Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, setting and status and event data as read only parameters should be without password protection.

xiv) Disturbance, Event Recording & data Storage Status, disturbance data and events shall be stored in non-volatile memory or memory backed up by battery. It should be possible to store minimum 50 events with date and time stamp, last 5 fault records and last disturbance record. When auxiliary power fails, it should be possible to see the latest state of display when power is restored. Also, in case of power supply failure lock out status of the relay should be stored and kept in memory to allow the working of interlock logic properly on restoration of the supply.

xv) Trip Circuit Supervision & Lock out function

xvi) Relay shall have built in lockout function. Lock out feature shall be self reset or hand reset and shall be software selectable.

xvii) For trip circuit supervision separate relay shall be provided.

xviii) Input / Output Interface, Filters and galvanic Isolation.

xix) Relay shall have at least 4 No contacts each shall separately be programmable for either hand reset or self-reset. The contact rating shall be minimum 5A at 250V AC / DC.

xx) Relay shall be made immune to capacitance effect due to long length cables.

xxi) All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

xxii) IEC 61850 protocol shall be used and shall be directly linked to DCS without converters. The numerical relays shall be provided with dual redundant ports for IEC 61850 communication and the numerical relays shall be connected in ring topology for linking to redundant controllers of DCS.

11.06.19 Intelligent Controllers

i) Each intelligent PCC, PMCC and MCC shall be provided with multi-function microprocessor based Numerical protective relay/ relay with intelligent controller.
This numerical relay shall have the following functions:-

a) Metering
b) Protection
c) Control
d) Monitoring
e) Communication through IEC 61850 protocol shall be used and shall be directly linked to DCS without converters. The Intelligent controllers shall be connected in daisy chain (in groups) or in star connection for linking to redundant controllers of DCS through Profibus using suitable device such as Y-link.

ii) Each panel shall be supplemented with required additional control element for features not covered by intelligent controllers.

iii) Numerical Relays of all modules in PCC / PMCC/ MCC shall be interlinked to DCS through open protocol IEC61850. Suitable hardware, software, cabling and any other interface requirement shall be taken care by this Bidder.

iv) Software for Numerical relays shall be supplied and shall be configurable from DCS based control system. Using this software, the following functions shall be carried out:-

a) Control of breakers (Close / Open / Trip)
b) Program or modify set points
c) Load or save set point from or to a disk
d) Read actual values
e) Monitor status
f) Read pre-trip data and trip record
g) Display dynamic trending of actual values
h) Get help on topic
i) Print

v) The device should have a control voltage of wide band from 110 to 240 V AC/DC, as applicable.

vi) Intelligent controller in a 415V / PMCC / MCC shall be directly interfaced to DCS control system through IEC 61850 Communication protocol for monitoring and through Hard wired interface for critical feedbacks and for commands with suitable interposing relay via remote I/O panel in MCC Room. The protection system should be independent / autonomous of the system i.e. motor protection & control should continue to be available even in the event of a communication or automation system failure.

11.06.20 Communication with DCS

i) Co-ordination between the switchgear manufacturer and DCS Supplier for protocol / mapping, procedures, interface and testing is included in the scope of services.

ii) Software for intelligent controller shall be supplied and suitably interfaced with DCS. It shall be possible to configure a device either individually or over a communication network. For this purpose, provision for connecting a laptop should be available at Numerical Relays/ Intelligent controller.

iii) Minimum of 2 Nos. laptop shall be provided along with PCCs / PMCCs / MCCs with all accessories, fully loaded software for Uploading / Downloading the switchgear data. In order to achieve minimum response time, the device shall be capable of transmitting data at a speed, suitable for operation with high speed bus systems.

11.06.21 Operations and Indications

i) Close/ open operations of all Incomer, Bus coupler & outgoing feeder breakers in “test” position, for all 0.415 kV feeders shall be through Push Buttons and test / service selector switches provided at the respective modules.

ii) Modules shall have ON, OFF & TRIP (LED indications provided.)

11.06.22 Interface with DCS

SL. NO.	DESCRIPTION	TYPE OF I/O
A.	**Incomer (ACB Controlled)**	
	Breaker Close	DO
	Breaker Trip	DO
	Line PT under voltage	DI
	Line PT Fuse Fail	DI
	Breaker ON	DI
	Breaker OFF	DI
	Incomer Disturbance (Control Supply Fail)	DI
	Numerical relay Unhealthy	DI
	Trip Coil Healthy	DI
	Incomer Available (Breaker in service/spring charged/ switchgear in remote)	DI

SL. NO.	DESCRIPTION	TYPE OF I/O
	Electrical Trip (Lockout relay optd)	DI
	Numerical relay	Interface through IEC 61850 protocol.
B.	**Incomer (MCCB Controlled)**	
	MCCB Close	DO
	MCCB Trip	DO
	Current feedback	AI
	MCCB ON	DI
	MCCB OFF	DI
	Incomer Disturbance (Contol supply fail)	DI
	Electrical Trip	DI
C.	**Bus Coupler (ACB Controlled)**	
	Breaker Close	DO
	Breaker Trip	DO
	Incomer-1 check Syn	DO
	Incomer-2 check Syn	DO
	Bus coupler check Syn	DO
	Breaker ON	DI
	Breaker OFF	DI
	Buscoupler Disturbance (Control Supply Fail)	DI
	Numerical relay unhealthy	DI
	Trip Coil Healthy	DI
	Bus-A Under Voltage	DI
	Bus-A PT Fuse Fail	DI
	Bus-B under voltage	DI
	Bus-B PT Fuse fail	DI
	DC Supply-1 fail	DI
	DC Supply-2 fail	DI
	Buscoupler Available (Bkr. In service/spring charged/swgr in remote)	DI
	Electric Trip (Lockout relay optd)	DI
	Numerical relay	Interface through IEC 61850 protocol
D.	**Bus Coupler (MCCB Controlled)**	
	MCCB Close	DO
	MCCB Trip	DO
	Current feedback	AI
	MCCB ON	DI
	MCCB OFF	DI
	Bus coupler Disturbance (Control Supply Fail)	DI
	DC Supply-1 Fail	DI
	DC Supply-2 Fail	DI
	Electrical Trip	DI

SL. NO.	DESCRIPTION	TYPE OF I/O
E.	**Outgoing ACB Feeder**	
	Breaker Close	DO
	Breaker Trip	DO
	Breaker ON	DI
	Breaker OFF	DI
	O/G Feeder Disturbance (Control Supply Fail)	DI
	Numerical relay unhealthy	DI
	Trip Coil healthy	DI
	O/G Feeder Available (Breaker in service/spring charged/swgr. In remote)	DI
	Electrical Trip (Lockout relay optd)	DI
	Numerical relay	Interface through IEC 61850 protocol
F.	**ACB Controlled Motor Feeder**	
	Start Command	DO
	Stop Command	DO
	ON Feedback	DI
	OFF Feedback	DI
	Electrical trip (Lockout relay)	DI
	Emergency LPBS Stop	DI
	Module Disturbance (Control supply fail)	DI
	Module available (Breaker in service position, Switchgear in remote & breaker spring charged)	DI
	Numercial realy unhealthy	DI
	Trip coil healthy	DI
	Numerical relays	Interface through IEC 61850 protocol
G.	**Undirectional LT Drive (MCCB/MPCB Controlled)**	
	Start Command	DO
	Stop Command	DO
	ON Feedback	DI
	OFF Feedback	DI
	Module disturbance (Control supply fail)	DI
	Emergency LPBS Stop	DI
	Intelligent Controllers	Interface through IEC 61850 protocol or Profibus.

SL. NO.	DESCRIPTION	TYPE OF I/O
H.	**Bidirectional LV Drive with Non-Integral starters (Soot blower)**	
	Forward Command	DO
	Reverse Command	DO
	Forward Feedback	DI
	Revers Feedback	DI
	Module disturbance (Control supply fail)	DI

NOTE: The above I/O shall be hard wired to DCS.

11.06.23 Metering and Protection

The feeders shall have the following protections / metering required for the switchgear panels. The minimum protections / metering required for various typical feeders including ACB operated feeders are given below. For non ACB controlled feeders having intelligent controller, the metering indicated shall be in-built.

i) ACB Controlled feeders with numerical relays

A)	Incomers		
	Protections	**Metering (for remote)**	**Local Indication**
	Instantanous over current protection 50	Current in all the three phases	Current in all the three phases
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selecter switch
	Instantanous earth protection 50N	kW	
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Under voltage protection 27		
	Restricted earth fault protection 64R		
	Backup (Standby) earth fault protection 64S		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and		

	shall not be clubbed with numerical relay.		
	Check synchronizing 25 through relay mounted in bus coupler.		
B)	**Bus Couplers**		
	Protections	**Metering (for remote)**	**Local Indication**
	Instantanous over current protection 50	Current in all the three phases	Current in all the three phases
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selecter switch for Bus A
	Instantanous earth protection 50N	kW	Voltmeter with voltage selecter switch for Bus B
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Under voltage protection 27		
	Check synchronizing 25		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		
C)	**Motor Feeders (90KW and above only)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Numerical Composite motor protection to cover a minimum of protections such as negative phse current (46), thermal over load (49), phase over current (50/51), earth fault (50N/51N), locked rotor (51LR), No. of starts per hour (66), breaker failure (50BF), under voltage (27 from PT)	Current in all the three phases	Current (Y phase)

	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.	kW, kWH	
D)	**Outgoing Feeder (630A and above)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Instantanous over current protection 50	Current in all the three phases	Current (Y phase)
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	
	Instantanous earth protection 50N	kW	
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		

ii) MCCB Controlled feeders rated below 630A.

A)	**Incomers (with motorized MCCB)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection	Current transducer (Y phase)	Current (Y phase)
	Short circuit protection		Voltmeter with voltage selector switch

B)	Bus Couplers (with motorized MCCB)		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection	Current transducer (Y phase)	Current (Y phase)
	Short circuit protection		
C)	**Outgoing Feeder (Below 630A) with MCCB (non motorized)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection		Current (Y phase)
	Short circuit protection		
D)	**Incomers for ACDB/MLDB/PDB MCCB (non motorized)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection		Voltmeter with voltage selecter switch
	Short circuit protection		Electronic energymeter with communication port suitable for IEC 61850 protocol

iii) Other feeders

A)	Bus PT / Line PT Modules		
	Protections	**Metering (for remote)**	**Local Indication**
	Under voltage protection 27	Voltage – phase to phase, phase to neutral	
	Fuse failure protection		
B)	**Motor feeders upto 15.0kW (MPCB with Contactors)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Intelligent controllers with current measuring module and overload & short circuit protection.		
C)	**Motor feeders above 15.0kW but below 90kw (MCCB with Contactors)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Intelligent controllers with current measuring module and Overload, single phase preventor & short circuit protection.	Phase current (for motors of rating 30KW and above)	

iv) DC System

A)	**Incomer Breaker/MCCB**		
	Protections	**Metering (for remote)**	**Local Indication**
	With indication only no protection with O/L alarm to DCS	Bus voltage	Load Voltage
			Bus Voltage
			Shunt with ammeter
B)	**Outgoing Feeder**		
	With indication only no protection with O/L alarm to DCS		Shunt with ammeter

Note:

Fuse failure relay shall be provided on the secondary side of voltage transformer to monitor HV and LV fuses.

11.06.24 Secondary wiring

i) The Switchgear/MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.

ii) Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks.

iii) Wiring shall be done with flexible, 1100V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5 sq.mm for current circuits and 1.5 sq.mm for voltage circuits and control circuits. Colour code shall be maintained for voltage and current circuits.

iv) Each wire shall be identified, at both ends with permanent tubular type printed markers bearing wire numbers as per Bidder's wiring diagrams. Each wire shall be ferruled by plastic tube with indelible ink print at both ends having terminal block no., terminal nos., destination no, as per approved drawing.

v) Wire terminations shall be made with crimping type connectors with insulating sleeves. Wire shall not be spliced between terminals. Fork type lugs shall be provided for all control terminals. The lugs shall be suitable for 2.5 sq.mm stranded copper conductor. However, C.T. wiring shall be done by using circular type lugs.

vi) For power wiring inside module copper cables are to be used.

vii) Terminal blocks with loose wires shall be provided in each shipping section for inter panel wiring.

viii) All control terminals shall be of 10 sq.mm size and shall be sliding type for draw out module and clip on type for fixed type module.

11.06.25 Terminal Blocks

i) Terminal blocks shall be 1100V grade box-clamp type with marking strips, similar to ELMEX 10 sq.mm or equal. Terminals for C.T. secondary leads shall have provision for shorting or any other equivalent new technology terminal blocks after approval of Owner.

ii) Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

iii) Terminal block shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

iv) Coloured terminal blocks for connection of power cables (R,Y,B phases) shall be provided.

v) Twisted pair 0.5sq.mm copper cable shall be used for DCS/BMS surface

11.06.26 Cable Termination

i) SWGR/PMCC / PCC/MCC/DB shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection.

ii) All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates cable supports, crimp type tinned copper/aluminium lugs, double compression type brass glands with tapered washer (power cables only) and terminal blocks. Terminating of power cables shall be shrouded to avoid accidental touch. Suitable supporting clamps shall be provided for cables to eliminate stresses on terminals.

iii) Twisted pair 0.5 sq. mm copper cable shall be used for DCS interface.

iv) Gland plates shall be minimum 3 mm thick. The gland plate and supporting arrangement for I/C Power cables shall be such as to prevent flow of eddy current.

v) Gland plates shall be easily removable type. The gland plate shall be mounted at 40/50 mm above the bottom of base frame of switch board.

vi) Cabling area above gland plate shall be free of any earth bus, neutral bus etc. so that the total gland plate area is usable for cabling and also do not obstruct removal of gland plate.

11.06.27 Busduct Connection

i) Busduct connections, wherever provided, shall be furnished along with transition panel if required.

ii) All connecting bus work shall have the same continuous rating as associated SWGR/PMCC / PCC/MCC bus and shall be fully braced for the specified short circuit current.

iii) All provisions such as matching flange and other accessories shall be furnished for connection to busduct.

iv) All the incomers from transformer shall be connected by Bus

11.06.28 Ground Bus

i) A ground bus made of copper/GI rated to maximum fault current shall be extended to full length of the Switchgear/MCC/DB.

ii) The ground bus shall be provided with two-bolt drilling with G.S. bolts and nuts at each end to receive 50x6 mm G.S. flat.

iii) Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and V.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.

iv) The frames of all other drawout modules shall be grounded through heavy multiple contacts at all times except when the power disconnects are separated by a safe distance.

v) Wherever the schematic diagrams indicate a definite ground at the SWGR/PCC/ MCC a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

vi) C.T. and V.T. secondary neutral shall be earthed through removable links so that earth of one circuit maybe removed without disturbing others.

vii) Door earthing shall be done by using 2.5 sq.mm stranded flexible copper conductor PVC insulated (Green colour).

11.06.29 Name Plates

i) Name Plates of approved design shall be furnished at each cubicle/control compartment, at the top of each Switchgear/MCC/DB and at each instrument and device mounted on or inside the cubicle.

ii) The material shall be lamicoid or approved equal 3 mm thick with white engraved letters on black background.

iii) The name plate shall be held by self-tapping screws. Name plate size shall be minimum 40 X 150 mm of 0.5mm thick for instrument/devices & 75 x 450 mm of 1mm thick for panels. The size of lettering shall be minimum 5 mm for module/feeder designation; however, component designation letter size shall be 6 mm.

iv) Caution notice on suitable metal plate shall be affixed at the back of each vertical panel for single front construction.

v) Board labels and panel Nos. shall be provided both on front and rear at two locations each if board is more than 10 meters in length.

11.06.30 Space Heaters and Plug Sockets

i) Each vertical section shall be provided with thermostat controlled space heater and 5A, 3 pin plug socket.

ii) In addition, motor feeders 30 KW and above shall be wired up for feeding the motor space heater through suitably rated starter auxiliary NC contact.

iii) Cubicle heater, Motor heater, plug socket circuit shall have individual switch fuse units.

iv) For valve / actuator provision of space heater supply shall be provided.

11.06.31 Tropical Protection

i) All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.

ii) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

11.07.00 PAINTING FOR SWGR/PCC/MCC/DB

11.07.01 All surfaces shall be subject to tank pretreatment process to produce a smooth, clean surface free of scale, grease and rust.

11.07.02 The SWGR/PCC/ MCC/DB and all other components shall be powdered coated as mentioned in Chapter 1.

11.07.03 Sufficient quantity of touch-up paint shall be furnished for application at site.

11.08.00 TESTS

11.08.01 During the fabrication switchgears shall be subject to inspection by Owner or its authorized representatives. Manufacturer shall furnish necessary information concerning the supply to Owner.

11.08.02 All routine tests shall be carried out at manufacturer's work under his care and expense, in the presence of Owner or his representative.

11.08.03 Stage inspection after the pre treatment and preparation of under surface and before final painting shall be carried out by Owner.

11.09.00 ROUTINE TEST

11.09.01 A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, terminal boxes, location and connection of terminal etc.

11.09.02 Manual and electrical operation of circuit breakers / relay shall be checked under the worst condition of the auxiliary voltage.

11.09.03 Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuit.

11.09.04 Insulation resistance of the main and auxiliary circuits shall be checked before and after high voltage withstand test.

11.09.05 Operation checks shall be carried out for every control function / interlocks as per the schematic diagrams by manually simulating fault condition and operation of the control switches / relay etc.

11.09.06 Relay shall be tested with secondary injection test equipment.

11.09.07 Primary injection test to check winding of current transformers, ammeter, ammeter selector switch and correction of wiring connection between them.

11.09.08 For equipment bought from other sub suppliers, certified test report of tests carried out at the manufacturer's works shall be submitted. Normally all the routine test specified in the relevant standards shall be conducted by the sub-supplier at his works.

11.09.09 Interchangeability of similar modules shall be checked on random basis. This may be done on one module of each size.

11.10.00 TYPE TEST

11.10.01 The type test certificate of similar rating of switchgear performed shall be submitted.

11.10.02 In case the Bidder is not able to submit report of the type test(s) conducted or in the case of type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests in the presence of the Owner without cost implication and submit the reports for approval.

11.11.00 TEST WITNESS

Test shall be performed in presence of Owner's if so desired by the Owner. The Bidder shall give at least fifteen (15) days advance notice of the date when tests are to be carried out.

11.12.00 DRAWINGS, DATA AND MANUALS

11.12.01 Following drawings/ data and Manuals to be submitted for approval.

i) Outline dimensional drawing showing general arrangement, space requirements and bus duct / cable entry points.

ii) Cross-section with parts list

iii) Foundation plan with loading

iv) Board-wise single line diagrams

v) Control schematics

vi) Wiring diagrams

vii) Consolidated Bill of Material

viii) Relay setting calculation

ix) Test Certificates and QAP

x) Bus bar sizing

xi) CT/VT sizing

xii) Technical leaflets

11.12.02 The Bidder shall also submit all instruction manuals clearly indicating the installation method, check-up and tests that are to be carried out before commissioning the equipment.

11.12.03 Bidders shall note that the drawings, data and manuals listed herein are minimum requirements only. The Bidders shall ensure that other necessary write-ups, curves and information required to fully describe the equipment are submitted during detail engineering.

DATASHEET FOR 415V PCC/PMCC/MCC/DBs

SL NO.	DESCRIPTION		SPECIFICATION REQUIREMENTS	
(a)	Rated voltage, phases and frequency		415V, 3 phase, 4 wire, 50 Hz.	
(b)	System neutral earthing		Solidly earthed	
(c)	Reference Ambient air temperature		50°C	
(d)	Material of bus bars		Al. or Al. Alloy	
(e)	Maximum temp. of bus bars joints, droppers and along the run at site reference ambient of 50°C With Plain or Tin joints With silver plated joints Bus enclosure and structure		*40°C* 55°C 30°C	
(f)	Short time rating for 1.0 Sec. (kA rms)		50	
(g)	Momentary rating (kA peak)		105	
(h)	Degree of protection for as per IS:2147		IP-54 for outdoor IP52 for indoor panels with current rating less than and including 1600A and IP 42 for panels with current rating more than 1600A	
(i)	Thickness of sheet steel in mm			
	(i)	Load bearing members	2	
	(ii)	Non-load bearing members	1.6	
(j)	Colour finish shade		Interior	Glossy white
			Exterior	As mentioned in Chapter 1.

SL NO.	DESCRIPTION	SPECIFICATION REQUIREMENTS	
Air Circuit Breaker			
1	Service	:	Indoor
2	Type	:	Air – break
3	Rated service voltage	:	415 V +/- 10%
4	Rated Current	:	As per requirement or 630A/1000A/1250A/2000A/2500A/ 3000A
5	Rated frequency	:	50 Hz +/- 5%
6	System earthing	:	Solidly grounded
7	Rated short time withstand current for 1 sec.	:	50 KA (r.m.s.)
8	Rated Symmetrical breaking current at rated voltage	:	50 KA (r.m.s.)
9	Rated making capacity (min)	:	105 KA
10	Rated operating duty	:	The duty of circuit breaker for motor feeder involves direct-on- line starting of motors. The motor starting current varies from 6 to 8 times the full load current at a very low power factor
			Frequency of starts of motors: Three (3) Starts per hour & Two (2) Consecutive Cold starts and one (1) hot restart.
11	Duty cycle	:	O-3 min-CO-3 min-CO
12	Operating mechanism	:	Stored energy type
	a) Closing	:	motor wound spring operated
	b) Opening	:	shunt trip coil
	c) Latching arrangement	:	Mechanically & Electrically trip free
13)	Auxiliary Voltage	:	
	Closing	:	220V D.C. (85% - 110%)
	Tripping	:	220V D.C. (70% - 110%)
	Spring charging motor	:	220 V +/- 10% D.C.
	Space heater & lamp	:	240 V+/- 10% AC 50 Hz
14	Anti-pumping feature	:	Electrical anti-pumping feature shall be provided.
15	No. of poles	:	3/4
16	Aux. Switch contact	:	Min (6 NO + 6 NC)
17	Mounting	:	Draw-out type transfer truck within switchgear cubicle
18	Limits of temp. rise	:	As per IS:2516 part I & II / Sec I
19	Termination	:	

SL NO.	DESCRIPTION	SPECIFICATION REQUIREMENTS		
	Incomer	:	Bus duct (top)	
	Outgoing	:	Armoured aluminum cable	
20	Static built in release	:	To be provided	
21	Finish paint shade	:	As mentioned in Chapter 1.	
	HRC FUSES	:		
	Type	:	Link type	
	Reference standard	:	IS : 9224	
	Rated current	:	As specified	
	Operation indicator	:	Required	
	Fuse characteristics	:	Bidder to furnish	
	CONTACTOR	**:**	**AC**	**DC**
1	Service	:	Indoor within steel cubicle for maximum system voltage, starting of motors and miscellaneous loads.	Indoor within steel cubicle for maximum system voltage, starting of motors and miscellaneous loads.
2	No. of Poles	:	3	2
3	Rated service voltage	:	415 V +/- 10%	220 V(190-240V)
4	Rated frequency	:	50 Hz +/- 5%	
5	System earthing	:	Solidly grounded	Ungrounded
6	Short time rating	:	To be coordinated with MCCB/MPCB Preceding it.	To be coordinated with MCCB/MPCB Preceding it.
7	Continuous current	:	To suit motor continuous current rating Conditions specified.	To suit motor continuous current rating Conditions specified.
8	Short circuit level	:	50 KA (rms) at 415 V	
9	Location of control	:	One point control Logic adopted	

SL NO.	DESCRIPTION	SPECIFICATION REQUIREMENTS		
10	Control circuit	:	110V ±10% 1-ph 50 Hz ± 5% derived from 415/110V control transformer provided in each control module.	
11	Utilization category	:	AC 3 for uni- directional motors	
			AC 4 for Bi-directional Motors.	
	CONTACTOR	**:**	**AC**	**DC**
12	Duty Class:	:	0.1	
	Intermittent class for Uni-directional motors (IS:2959)			
	Intermittent class for Bi-directional motors (IS:2959)	:	0.3	
13	Aux. Contact requirement	:	Min. 2 NO &	
			2 NC contacts	
14	Limits of operation	:		
	Closing (pick-up)	:	85% to 110%	
	Dropout	:	45 – 65% of rated	
15	High voltage test values (one Min. value)	:		
	a. Main power circuit	:	2.5 KV	
	b. Control & auxiliary circuit volts	:	2.0 KV	
16	Limits of temperature	:	As per IS:2959	
CURRENT TRANSFORMERS				
1	Service	:	Indoor	
2	System	:	415V, 3 phase, 4 wire, 50Hz, Solidly earthed neutral	
	Insulation class		E or better.	
3	Type	:	Resin cast	
4	Rated voltage	:	415 V +10%	

SL NO.	DESCRIPTION	SPECIFICATION REQUIREMENTS	
5	Quantity required	:	As per requirements of individual feeders and as mentioned in the specification drawings.
6	Ratio and burden	:	As required, C.T. secondary rating shall be 1 AMP.
7	Accuracy	:	5P10 or better for protection and class-1 for metering.
8	Power frequency withstand voltage	:	2.5 KV (r.m.s) for one minute
9	Rated short time current	:	
10.	Short time withstand current for 1 sec	:	50 KA (r.m.s)
11.	Dynamic current	:	105 KA (peak)
12	Mounting	:	Inside switchgear cubicle in stationary portion.
	Potential Transformer		
1	Service	:	Indoor
2	System	:	451V, 3 phase, 4 wire, 50 Hz, Solidly earthed neutral
3	Type	:	Cast resin
4	Rating- Voltage ratio	:	415/√3 / 110/√3
5	Rated burden	:	As specified
6	Accuracy class	:	As per requirement, to be furnish during detail engineering
7	Power frequency withstand voltage	:	Primary: 11.0 KV for one minute
			Secondary : 2.0 KV for one minute
8	Mounting	:	Fixed type
9	Quantity	:	As per requirement

Microprocessor based numerical relays with communication facility

The numerical relays for 0.415KV Switchgears shall comply with but not limited to the following technical requirements.

S. NO.	DESCRIPTION	:	SPECIFICATION
1	Purpose	:	Control & Protection, Metering and Monitoring of all switchgears and MCCs with synchro-check facility for Incomers, Bus couplers.
2	Auxiliary Supply	:	220V DC for ACBs and 110V AC for MCC only.
3	CT Secondary Current	:	1Amp.
4	PT Secondary Voltage	:	110V AC, 3 Phase
5	Ambient Temperature	:	50^{o}C
6	Degree of protection	:	IP 54
7	Communication	:	Compatible with DCS system through suitable connectivity (IEC61850) & suitable software.
8	Input & Output	:	Required number of analog and digital inputs/outputs as per scheme requirement with spare.
9	Control		Close / open control of breakers through lap top from the front fort/through key pad (Built in)/ through rear port connection from DCS.
10	Metering	:	Instantaneous and Integrated values as indicated.
11	Protection	:	Complete protection for Incomer, Tie, Bus coupler, feeders as indicated.
12	Monitoring	:	Self-diagnostic facility.
	Facilities to be made available in the relay		Programming keys for complete access without computer (built in). Provision for external programming unit through suitable software and communication ports. Display unit. Read/Write set points. Current & Voltage actual values and any other analog measurement. Event recording with Pre-trip data with starting characteristics. Statistical data. Output relays. Tamper proof security system

SECTION – 14: AC & DC MOTORS

14.01.00 SCOPE

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

14.01.01 Site Conditions

Site conditions are covered in 'Project Data', contained in specification of the driven equipment.

14.01.02 Gases, Fumes & Dust Particles

General - Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

14.01.03 Dust Particles

i) Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.

ii) Indoor Locations.

iii) Coal conveyors - As for outdoor as per clause 14.01.3 (i) above.

iv) Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

14.01.04 Special Fumes

i) Water treatment plant and acid cleaning room - Acid and alkali fuses present.

ii) Fuel oil pumping areas & Hydrogen generation plant - Explosive fuses (flameproof motors required).

iii) For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

14.02.00 LOCATION OF MOTOR - As required

14.03.00 CODES STANDARDS

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

Code	Name of standard
IS : 325	Specification for three phase induction motor.
IS : 900	Code of Practice for installation and maintenance of induction motors
IS : 996	Single phase AC motors
IS : 1231	Dimensions of three-phase foot-mounted induction motors
IS : 1271	Thermal evaluation and classification of electrical insulation.
IS : 2223	Dimensions of flange mounted ac induction motors.
IS : 2254	Dimensions of vertical shaft motors for pumps
IS : 3043	Code of practice for earthing.
IS : 3177	Crane duty motors
IS : 4029	Guide for testing three phase induction motors.
IS : 4691	Degree of protection for enclosures of rotating electrical machinery.
IS : 4722	Specification for rotating electrical machinery.
IS : 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS : 4889	Methods of determination of efficiency of rotating electrical machines.
IS : 5571	Guide for selection of electrical equipment for hazardous areas.
IS : 6362	Designation of Method of Cooling of Rotating electrical machines.
IS : 8223	Dimensions and output ratings for foot mounted rotating electrical machines with frame numbers 355 to 1000.
IS : 8789	Values of performance characteristics for three phase induction motors.
IS : 12065	Noise level of motors.
IS : 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS : 12615	Induction motors - Energy efficient, three-phase, squirrel cage – Specification
IS : 12802	Temperature rise measurement of rotating electrical machines.
IS : 12824	Temperature rise measurement of rotating electrical machines

IS : 12824	Type of duty and classes of rating assigned.
IS : 14222	Requirements and method of Impulse withstand test
IEC: 60034-1	Rotating electrical machines.
ISO : 1940-1	Mechanical vibration – Determination of permissible residual unbalance
NEMA, MG-1	Motors and Generators
DIN/IEC/IS	RTD
BS 5308 part II	RTD triad Cable

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

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

14.04.00 TYPE

14.04.01 AC Motors:

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

ii) Continuous duty LT motors rated above 0.37kW upto 200 KW Output rating (at 50 deg. C ambient temperature), shall be **Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30. However this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.

iii) Crane duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF.

14.04.02 DC Motors shunt wound.

14.05.00 VOLTAGE (NOMINAL)

14.05.01 LV Motors

For motors upto and including 200 KW - Four hundred fifteen (415) V.

14.05.02 MV Motors

For motors above 200 kW upto and including 2000kW. Six point six (6.) kV.

14.05.03 HV Motors

i) For motors above 2000kW - eleven (11) KV
ii) All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

14.06.00 FREQUENCY (NOMINAL) - fifty (50) Hertz

14.07.00 NUMBER OF PHASES - Three (3)

14.08.00 SPEED - As required by the driven equipment

14.09.00 TYPE OF STARTING - Direct on-line

14.10.00 DUTY

14.10.01 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency and voltage variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

14.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.

14.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly co-ordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon on driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.

14.10.04 Maximum torque shall not be less than 205% of full load torque.

14.10.05 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.

14.10.06 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.

14.10.07 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.

14.10.08 All LV motors rated 0.37kW and higher upto and including 200kW (LV Motors) with S1 duty shall be compulsorily be of energy efficiency level IE 3 as per IS 12615:2011.

14.10.09 HV & MV motors shall have full load efficiency of 95% minimum and rated full load power factor of 0.8 minimum. The required power factor shall be achieved without using external capacitor.

14.11.00 SUPPLY VARIATIONS …… Motors shall be capable of running continuously at full load under following variations in power supply.

14.11.01 Voltage (percent of nominal voltage) ……. Plus minus (±) ten (10) for LT
Plus minus (±) Six (6) for MV & HT

14.11.02 Frequency (percent of minimal frequency)…….. Plus Three 3 & minus (-) five (5)

14.11.03 Combined voltage & frequency (percent) ……. Ten (10) (sum of absolute percentage value of voltage and frequency variation)

14.12.00 ABNORMAL CONDITIONS CAPABILITY

Motor shall have following capabilities as specified design ambient temperature:-

14.12.01 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.

14.12.02 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

14.12.03 Low Voltage Running:-

Motor shall be capable of running satisfactorily at seventy five (75) percent nominal voltage for five (5) minutes.

14.12.04 Momentary Low Voltage Withstanding:

Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

14.13.00 STARTING CAPABILITY

14.13.01 Low Voltage Starting

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80) percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

14.13.02 Cold Motor Starting

Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes. (with initial temperature of the motor at ambient temperature)

14.13.03 Hot Motor Starting

Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes. (with initial temperature of the motor at full load operating level)

14.13.04 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

14.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

i) Motors upto 1000 KW ..... 600% subject to IS Tolerance of plus 20%

ii) Motors (above 1000 KW upto 3000 KW) ..... 600%. Subject to 20% IS tolerance.

iii) Motors above 3000 KW.....450%. Not subject to any positive tolerance.For energy efficient

iv) LT motors, locked rotor current shall be as per IS: 12615.

v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance

14.14.06 Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.

14.14.00 STARTING VOLTAGE REQUIREMENT

14.14.01 All Motors (except Mill Motors)
i) 80% of rated voltage for Motors upto 4000 kW
ii) 75% of rated voltage for Motors above 4000 kW

14.14.02 For Mill Motors:

i) 85% of rated voltage for Motors above 1000 kW
ii) 90% of rated voltage for Motors below 1000 kW

14.15.00 TORQUE REQUIREMENTS

14.15.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10%. Motor full load torque.

14.15.02 Full out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

14.16.00 STARTING TIME

14.16.01 For motors with starting time up-to 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at-least 2.5 secs. more than starting time.

14.16.02 For motors with starting time more than 20 secs. and up-to 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at-least 5 secs. more than starting time.

14.16.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at-least 10% of the starting time.

14.16.04 At no stage, speed switch shall be provided to achieve requirements mentioned in Clause No. 14.16.01 to 14.16.03.

14.17.00 CLASS OF INSULATION

14.17.01 LV Motors ..... Class F.

14.17.02 HV & MV Motors ..... Class F

14.17.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both MV, HV & LT motors. The temperature under abnormal running conditions shall be limited to 5^{o}C above class ‘B’ limits.

14.17.04 The value of the polarization index for motors above 200kW should not be less than 2 when determined according to IS: 78114.0

14.17.05 For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages,

14.17.06 HT motors shall withstand 1.2/50 micro sec impulse Voltage wave of 4U+5 kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034 – Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

14.18.00 TEMPERATURE RISE UNDER NORMAL CONDITIONS

14.18.01 Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
i)	50^0C	60^0C	70^0C

14.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method.

14.19.00 BUS TRANSFER WITHSTAND CAPABILITY

Motors shall be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The manufacturer/ vendor shall indicate the special precautions taken to meet the above requirements and confirm.

14.19.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

14.19.03 That the motor winding's shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

14.19.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

14.20.00 TYPE OF ENCLOSURE

14.20.01 Outdoor Motors.....IP 55 (Additional canopy to be provided by Bidder).

14.20.02 Indoor Motors ..... IP 55

14.20.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

14.21.00 METHOD OF COOLING

14.21.01 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).

14.21.02 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

14.22.00 TYPE OF MOUNTING ..... As required for the driven equipment.

14.23.00 MAXIMUM MECHANICAL VIBRATIONS

Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.

14.24.00 NOISE LEVEL

14.24.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). at 1m from operating motor measured in accordance with IS: 10265.

14.24.02 Motor body shall have two earthing points on opposite sides.

14.24.03 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

TABLE – I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

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

14.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

14.24.05 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

14.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

14.25.00 WINDING & INSULATION

14.25.01	Type	:	Non-hygroscopic, oil resistant, flame resistant
14.25.02	11kV & 6.6 kV AC motors	:	Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be of copper. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & inter-turn insulation surge withstand level shall be as per IEC-60034 part-15
14.25.03	240VAC, 415V AC & 220V DC motors	:	Thermal Class(F)

14.26.00 DIRECTION OF ROTATION

14.26.01 As needed by driven equipment.

14.26.02 The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

14.26.03 If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

14.27.00 BEARINGS

14.27.01 Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.

14.27.02 Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.

14.27.03 If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.

14.27.04 Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.

14.27.05 For MV & HV motors rated 1000KW and above , the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.

14.27.06 When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.

14.27.07 Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.

14.27.08 Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.

14.27.09 Bearings shall be of internationally reputed make subject to the approval of the Owner/Consulting Engineer.

14.27.10 Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.

14.28.00 **SHAFT EXTENSION** ..... Key slotted bare shaft extension of required length with key on driving end.

14.29.00 **DRAIN HOLES** ..... Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.

14.30.00 **LIFTING DEVICES** ..... Motors shall be provided with eye-bolts, lugs or other means to facilitate safe lifting.

14.31.00 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven equipment assembly) or at site after erection (for separate supplies of above equipment).

14.32.00 **CENTERING SPIGOT**..... Flange mounted motor shall have centering spigot to match driven equipment socket.

14.33.00 **EASE OF MAINTENANCE**..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

14.34.00 **NAMEPLATES**..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:-

14.34.01 In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

14.34.02 Temperature rise under normal/abnormal conditions.

14.34.03 Type of bearing and recommended lubricants.

14.35.00 FINISH

14.35.01 Motor shall have synthetic enamel paint shade as mentioned in Chapter 1.

14.35.02 All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

14.36.00 TERMINAL BOXES

14.36.01 General

i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.

ii) The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core

cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box.

iii) Terminal bushings and clamps shall be non-absorbent, non-inflammable, insulated material for connecting with cable.

14.36.02 Main Terminal Box

i) LV Motors ..... Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing.

iii) Neutral terminal box for HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.

iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables.

v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.

vi) Phase to Phase/ Phase to Earth Air Clearance:-

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

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

vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

14.37.00 **TYPE AND SIZE OF CABLES**

14.37.01 Space Heaters

i) For LV Motors: Two point five (2.5) mm^2, two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).

ii) For MV & HV Motors: Six (6) mm^2 two core aluminium conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).

iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm^2 ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm^2, ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).

iv) Bearing Temperature Indicators - For each indicator, 0.5 mm^2 six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.

v) For Moisture Detectors.....As for space heaters as per Clause 14.041.1 (i) above.

14.37.02 For Main Terminals:-

i) LT Motors

a) Three (3) core cables .....Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).

b) Single core cables .....Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

ii) HV & MV Motors

Three (3) core cables ..... stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 6.6 KV / 11 KV un earthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

14.38.00 GROUNDING

14.38.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

14.38.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.

14.38.03 HV & MV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

14.39.00 EMBEDDED TEMPERATURE DETECTORS

HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C

14.40.00 BEARINGS TEMPERATURE INDICATORS

HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to operate at lower value to give alarm and other set at a higher value to trip the motor.

14.41.00 SPACE HEATERS

14.41.01 Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.

14.41.02 The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

14.41.03 The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

14.42.00 HOT AIR TEMPERATURE DETECTOR

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). In addition one (1) duplex type RTD shall be provided in each enclosure for alarm and if trip is required for cooling air temperature, temperature switch shall be provided.

14.43.00 WATER FLOW INDICATOR

If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits. In addition one (1) duplex type RTD shall be provided in each water inlet and outlet circuit

14.44.00 MOISTURE DETECTORS

Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

14.45.00 BED PLATE

Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

14.46.00 OTHER ACCESSORIES

Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

14.47.00 TESTS

14.47.01 HV & MV Motors

i) Routine Tests

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Owner's representative, for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests

a) For each type & rating of HV & MV motors the Bidder shall submit for Owner's approval the reports of all the type tests as per relevant standards. These reports should be for the tests conducted on the equipment similar to those proposed to be

supplied under this contract and the test(s) should have been conducted at an independent laboratory. Period - With in 5 Years from the zero date.

b) In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval, for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

a) No load saturation and loss curves upto approximately 115% of rated voltage.

b) Measurement of noise at no load.

c) Momentary excess torque test.

d) Full load test

e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose. In case due to test bed limitations at the manufacturing works, mixed frequency method as per latest IEC 60034 is also acceptable.

f) Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15

g) Surge-withstand test on interturn insulation shall be as per clause no. 5.1.2 of IEC60034, part-15

h) Degree of protection test for the enclosure followed by IR, HV and no load run test.

i) Terminal box-fault level withstand test for each type of terminal box.

j) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.47.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of Consultant /Owner or his representative.

ii) List of minimum tests for which reports have to be submitted

The following minimum type test reports shall be submitted for each type and rating of LT motor of above 30 KW only

a) Measurement of resistance of windings of stator and wound rotor.
b) No load test at rated voltage to determine input current power and speed.
c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
d) Full load test to determine efficiency power factor and slip.
e) Temperature rise test.
f) Momentary excess torque test.
g) High voltage test.
h) Test for vibration severity of motor.
i) Test for noise levels of motor(Shall be limited as per clause No. 14.24.00 of this section)
j) Test for degree of protection and
k) Over speed test.
l) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

iii) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.48.00 INFORMATION WITH PROPOSAL

14.48.01 AC Motor Data Sheet.

14.48.02 Dimension Drawing/Foundation load details of motor and driven equipment.

14.48.03 Manufacturer's catalogue showing constructional details.

14.49.00 INFORMATION ON AWARD OF CONTRACT

14.49.01 Motor Data Sheet

Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

14.49.02 Following characteristics curves:-

i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment except for mill motor. For mill motor torque speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment

ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage

iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor thermal withstand curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

v) Efficiency, power factor, current and speed versus power output curves.

vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor speed time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

vii) Negative phase sequence current withstand characteristics.

14.50.00 DC MOTOR

14.50.01 D.C. Motor provided for emergency service shall be shunt / compound would type. The starting current shall be as per manufacturer's standard.

14.50.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

14.50.03 Starter panel complete with all accessories shall be included in the scope of supply.

14.51.00 **DRAWINGS, DATA & MANUALS**

14.51.01 Minimum Drawings, data & manuals for the motors to be submitted

i) Dimensional General Arrangement drawing
ii) Foundation Plan & Loading
iii) Cable end box details
iv) Space requirement for rotor removal
v) Thermal withstand curves hot & cold

vi) Starting and speed torque characteristics at 80% & 100% voltage except for mill motor. For mill motor Starting and speed torque characteristics at 90% & 100% voltage.
vii) Complete motor data
viii) Erection & Maintenance Manual
ix) Test reports
x) QAP

DATASHEET

	Auxiliary power supply	
1.1	**HV supply**	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed Earthed through resistance, limiting earth fault current to 400 Amps	Motors rated above 2000 kW
	Fault level	50 kA for 1 second
	HV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.2	**MV supply**	
	6.6kV, 3Φ, 3W, 50 Hz non effectively earthed. Earthed through resistance, limiting earth fault current to 400 Amps	Motors above 200kW upto and including 2000kW
	Fault level	40 kA for 1 second
	MV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.3	**LV supply**	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
	LT motors rated up to 90 kW	shall be controlled through MPCB/ MCCB and contactor.
	LT motors rated more than 90 kW	Shall be controlled through air circuit breaker
1.4	**DC supply**	
	220V,2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	

	voltage	------
	Frequency	------
	Combined voltage & frequency	--------
2.2	DC supply	198 to 240 V
Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.		

1.0	Design ambient temperature		:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor		:	Upto 200KW
3.0	Installation (Indoors/ Outdoors)		:	As required
4.0	Degree Of Protection		:	IP55
5.0	Cooling		:	TEFC / TETV / CACA
6.0	Details of supply system			
	a)	Rated voltage (with variation)	:	415V $\pm$ 10%
	b)	Rated frequency (with variation)	:	50 Hz (Variation: +3% and –5%)
	c)	Combined voltage & freq. variation	:	10% (sum of absolute values)
	d)	System fault level at rated voltage	:	50 kA for 1 sec
	e)	Short time rating for terminal box	:	50 kA for 0.25 sec
	f)	LV System grounding	:	Solidly
7.0	Class of insulation		:	Class ‘F’, with temp rise limited to class B.
8.0	Minimum voltage for starting		:	80% of rated voltage
9.0	Power cables data		:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material		:	Shall be given during Detailed engg.
11.0	Space heater supply **(30KW & ABOVE)**		:	240 V, 1Φ , 50 Hz
12.0	TYPE OF STARTER PROVIDED IN MCC		:	DOL
13.0	Locked rotor current			
	a)	Limit as percentage of FLC	:	As per IS 12615
14.0	Additional tests		:	As per QP
15.0	Flame-proof motor			
	a)	Enclosure suitable (As per IS:2148)	:	As per requirement
	b)	Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
	c)	Degree of protection	:	IP65
16.0	Makes		:	AS PER ANNUXURE-I
17.0	Terminal box		:	Suitable to rotate at 90 degrees
18.0	Paint shade		:	Shall be given during Detailed engg.
19.0	Efficiency class		:	IE3

Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.

	QUALITY PLAN	CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
	SHEET 1 OF 2	SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
	BHEL		**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01	SPECIFICATION : TITLE :
	SHEET 2 OF 2	SYSTEM	ITEM AC ELECT. MOTORS BELOW 55KW (LV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

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

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

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SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

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									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

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1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

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	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

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SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

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1	2	3	4	5	6	7	8	9	10	10	10	11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**

NOTES:

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

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

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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SECTION – 18: LV POWER CABLES

18.01.00 SCOPE OF SUPPLY

i) The LV Power cables shall be supplied, installed and commissioned in accordance with the following specification.

ii) Other cables including special cables if any which are necessary as per proven engineering practice for satisfactory & trouble free operation of the entire cable system of the power plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

18.02.00 CODES & STANDARDS

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

IS:1554 (Part-I)	PVC insulated (heavy duty) electric cables for working voltage up to and including 1100 V.
IS: 2982	Copper conductor in insulated cables and cords.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanized steel wires, formed wires and tapes for armouring of cables.
IS : 4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part - I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Drums for electric cables.
IS : 10810	Methods of tests for cables.
IEC: 60	High voltage test techniques
IEC: 230	Impulse tests on cables and their accessories
IEC: 287	Calculation of the continuous current rating of the cables (100% load factor).
IEC: 288	Nominal cross sectional area and composition of conductor of insulated cables.
IEC-331	Fire resisting characteristics of electric cables
IEC: 502	Extruded solid dielectric insulated power cables for rated voltages from 1kV up to 30kV.
IEC: 540	The methods for insulations and sheath of electric cables and cords(elastomeric and thermoplastic compounds)
IEC-754 (Part-I)	Test on gases evolved during combustion of electric cables.
IEC -60332	Tests on Electric cables under fire conditions. Part-3 : Tests on bunched wires or cables (category -B)

IEEE-383	Standard for type test of Class IE Electric Cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
NES-715-1	Temperature index
SS-4241475 classF3	Swedish Chimney test
	SVENSK Standard SS-4241475 Class F3

ii) BICC Hand Book For cables in fire regarding temperature index-chapter-6

iii) Indian Electricity Rule.

iv) Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted subject to approval of the Owner. In such case, copies of the English version of the standards adopted shall have to be submitted along with the bid.

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

18.03.00 DESIGN CRITERIA

i) The cables shall be used for connection of power circuits of the system. Actual cable sizes shall be selected based on approved sizing calculations. Number of different sizes selected shall be kept to a minimum for optimization.

ii) Cables shall be generally laid on ladder type cable trays. For interplant connection cables shall be routed along overhead cable bridge.

iii) For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification.

iv) The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

v) The inner and outer sheath shall have flame retardant low smoke (FRLS) characteristics or fire survival characteristics as the case may be, and shall meet the requirements of additional tests specified for the purpose.

vi) Core identification for multicore cable shall be provided by colour coding.

vii) Cables shall be so designed and manufactured that no damage occurs during handling, transit, storage, installation under any operative conditions which they may be subjected to.

viii) Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

ix) Power cables shall be chosen taking into account the factors mentioned in Section-I.

18.04.00 SPECIFIC REQUIREMENTS / CONSTRUCTIONAL REQUIREMENTS

18.04.01 1.1KV Aluminium Conductor Power Cables

i) 1100 volt, 90 Deg. C rating, heavy duty power cables with stranded aluminium conductor, extruded XLPE insulation, extruded PVC,FR-LS inner sheath, aluminium round wire armour for single core cables and galvanized steel strip /wire armour for three (3) core cables, and extruded PVC, FR-LS overall sheath. Cables shall be manufactured in conformity to IS-7098 part 1 - 1988, amended up to date and bearing ISI mark.

iii) Conductor

The cable conductor shall be made from standard Aluminum of grade H2 and Class 2 to form compact conductor having a resistance within the limits specified. All the cables of size 25mm2 and above shall have sector shaped conductors.

iv) Insulation

The insulation shall be XLPE type. It shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The insulation of the cables shall be of high standard quality.

v) Inner Sheath

a) The laid up insulated cores of twin and multicore power cables shall be provided with an inner sheath of extruded FRLS PVC, compound conforming to Type ST2 of IS:5831. Single core power cables need not be provided with any inner sheath.

vi) Armour

a) For single core armoured cables, armouring shall be of aluminium wires/formed wires of H4 grade.

b) For multicore armoured cables, armouring shall be of galvanised steel strip /wire.

vii) Overall Sheath

a) Outer sheath shall be of extruded FRLS PVC compound conforming to type ST2 as per IS: 5831 & black in colour. In addition to meeting all the requirments of Indian standards referred to, outer sheath of all the cables shall be applied with anti rodent and termite additives.

18.04.02 1.1KV Grade Copper Conductor Fire Survival Power Cables

i) 1100 volt grade, 90 Deg. C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984. The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988. The cables can withstand 750 Deg. C temperature for three (3) hours.

ii) Conductor

a) Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.

b) A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

iii) Insulation

a) Cores of the cable shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue & Black

iv) Laying up of cores (For multi core cables only)

a) The core shall be suitably identified in accordance with IS: 9968 (Part-I).

b) The suitable fire retardant material fillers shall be used for filling in the interstices.

c) Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

v) Inner Sheath

a) An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores. This shall be provided even for single core cables after providing two layers of plain glass fiber tape over the insulation.

vi) Armour

a) For Single core cables to be used in A.C system, the armouring over inner sheath shall consist of single layer of round copper wire.

b) For multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanized steel wire.

vii) Outer Sheath

a) The extruded outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.

b) Minimum value of 'Tensile Strength' and 'Percentage elongation rat rupture' shall be 8 Newton/Sq. mm and 250% respectively.

c) The colour of outer sheath shall be black or any other colour agreed mutually between Owner and Supplier.

18.04.03 Flexible Trailing Cables

1100 V Grade flexible trailing cable shall be tinned copper of Class – 5 of IS – 8130, heat resistant electrometric compound based on EPR insulation, inner sheath of heat resistant electrometric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty electrometric compound FRLS CSP outer sheath.

18.05.00 GENERAL REQUIREMENTS

18.05.01 Drum Length & tolerance

i) Cable shall be supplied in wooden drums. The standard single length of each drum shall be minimum 500 metres for large size of cable minimum 1000 metre for smaller size of cables.

ii) 1.1KV Copper Fire Survival Power cables shall be supplied in wooden drums. Each drum shall be minimum 500 metres single length of cable.

iii) Allowable tolerance on individual drum length is (+) 5%.

18.05.02 Non-standard length

Contractor shall be required to obtain Owner's approval before packing the non standard length of cables on drums. Non-standard lengths shall not be less than half of the standard packing length in any case.

18.05.03 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

a) TANGEDCO
b) Manufacturer's name or trademark
c) Voltage grade
d) Year of manufacture
e) Type of insulation and sheath, e.g. XLPE /PVC FRLS, IE2/SE3 F.S. as applicable.
f) No. of core and size of cables.
g) Sequential length marking at an interval of 1m through out the length of the cable.
h) ISI mark with C/ML Number
i) Type of improved fire performance, e.g. FR / FR-LSH / FS.

18.05.04 Packing

i) Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden drums shall be treated by immersing in copper nitrate solution

ii) Cable shall be wound and packed on drums in such a manner that it shall be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose

iii) A label shall be securely attached to each end of the reel indicating the length, type, voltage grade, conductor size and number of core of the cable. A tag containing the same information shall be attached to the leading end of the cable inside. An arrow and necessary instructions

shall be marked on the drum indicating the direction in which it should be rolled. Drum numbers are to be indicated on cable drums.

iv) The cable drums should carry the following details in printed form (non returnable):-

a) TANGEDCO & Manufacturer's name or trade make
b) Type of cable & voltage grade
c) Year of manufacture
d) Type of insulation / sheath e.g. XLPE /PVC FRLS, IE2/SE3 F.S. as applicable.
e) No. of core and size of cables
f) Cable code
g) Length of cable on drum
h) Direction of rotation, by arrow
i) Approx. gross mass.
j) ISI mark
i) IS / IEC number

18.06.00 TESTING PROCEDURE

18.06.01 Tests During Manufacture:-

During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to Owner's representative during inspection / testing.

18.06.02 Type Tests:-

i) Cables shall be type tested quality. For each type and rating of cables reports on all type tests as per relevant standards, and carried out with in last five years from the zero date shall be submitted.

ii) These reports shall be for the tests conducted on the similar type of cables proposed to be supplied under this contract. These tests should have been conducted with in last 5 years from the zero date at an independent laboratory. If type test certificate are not available or in the case of type test report(s) are not found to be meeting the specification requirements, the same shall be conducted in the presence of the Owner free of cost.

18.07.00 SPECIAL TESTS ON PVC 'FR-LS' MATERIAL

i) All the sizes of XLPE power cables of the 'FRLS' PVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LS' type 'PVC' to meet these special tests:-

a) Oxygen/Temperature Index test on sheath material:-

b) This test shall be carried out as per American National Std. A STM-D-2863/77.

c) The minimum oxygen index shall be 29 at room temperature.

d) For determination of the temp.index, the oxygen index test shall be carried out at different temperature upto 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temperature index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

ii) Acid gas emission test on sheath material:-

This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20 by weight.

iii) Smoke density test on sheath material:-

This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). The ASTM test method is compulsory. For passing this test, the requirement of light transmission shall be minimum 40% after the test.

iv) Flammability test on finished cable sample:-

This test shall be carried out as per the following method:

v) Swedish Std.SS:424-14-75 Class-F3. This test known as Swedish Chimney test is compulsory.

vi) IEEE std. 383-1974 – This test known as the vertical tray flame propagation test shall be conducted if insisted by Owner.

vii) IEC Std: 332-1. – The cable should meet the requirement of all the above standards.

18.08.00 ROUTINE TESTS

The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985:-

a) High Voltage Test
b) Conductor Resistance Test
c) Partial discharge test (for screened cables) – on full drum length.

18.09.00 ACCEPTANCE TEST

i) The following test shall be carried out as Acceptance Test in the presence of TANGEDCO Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's/supplier's cost:-

a) High Voltage Test
b) Conductor Resistance Test

c) Tensile / wrapping test.
d) Partial discharge test (In screened cables).
e) Insulation Resistance/Volume resistivity test
f) Measurement of thickness of insulation and sheath and other dimensions
g) Tensile strength & elongation at break for insulation & sheath.
h) Hot set test on XLPE insulation
i) Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)
j) Acid gas generation test as per IEC-754-1.
k) Smoke density test as per ASTM-D-2843/1977
l) Oxygen index test as per ASTM-D 2863/1977
m) Temp. index test as per ASTM-2863/77
n) Test for Rodent and termite repulsion property

18.10.00 TEST WITNESS

Tests shall be performed in presence of Owner's representative. The Contractor shall give atleast fifteen (15) days advance notice of the date on which the tests are to be carried out.

18.11.00 TEST CERTIFICATES

i) Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner's representative.

ii) Test reports shall be completed with all details and shall also contain IS/IEC specified limit values, wherever applicable, to facilitate review.

iii) The cables shall be dispatched from works only after receipt of Owner's written approval of the test reports.

18.12.00 DRAWINGS, DATA AND MANUALS TO BE FURNISHED FOR APPROVAL

Bidder shall submit the following minimum drawings and documents for approval during detail engineering stage.

- Design basis report
- Cable sizing calculation
- General arrangement drawings
- Technical data sheet
- Test reports
- Catalogues
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

DATA SHEET

1100 V grade, power cable conforming to following requirement and in line with IS-1554, IS-5831, IS-8130 & IS-3975.			
S.NO.	**DESCRIPTION**	**:**	**SPECIFICATION**
1	Conductor	:	Stranded and compacted plain aluminium of grade H2 and class 2/stranded, high conductivity annealed plain copper, generally conforming to IS:8130
2	Insulation	:	Extruded Cross linked Polyethylene (XLPE).
3	Inner Sheath	:	Extruded FRLS PVC compound conforming to type ST2 of IS: 5831 for multicore cable. Single core power cables need not be provided with any inner sheath.
4	Armour	:	Galvanised single round/ strip steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 grade for single core cables.
	Overall Sheath	:	Extruded FRLS PVC compound conforming to type ST2 of IS: 5831.

SECTION-20: CABLING SYSTEM

20.01.00 SCOPE OF WORK

20.01.01 The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling, fire stop mortar seal, fire retardant cable coating system etc. the scope shall broadly cover, but not be limited to:

i) TG Building & Transformer Yard
ii) Boiler Area, ESP
iii) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the general electrical specification/ plot plan & related drawings.
iv) Service Building
v) CPU Regeneration Building
vi) Fuel Oil Pressurisation Pump House
vii) DG House
viii) Pipe cum cable rack (within the battery limits).
ix) Air Washer Units
x) All electrical equipment as described in different sections.
xi) As built drawing for all above systems on completion of project.

20.01.02 The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

20.02.00 SCOPE OF SUPPLY

20.02.01 The equipments and materials within the scope of supply shall include but not limited to:-

i) Power & control cabling works (including that of special cables):

ii) Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.

iii) Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.

iv) Supply and installation (including laying & termination) of all power cables (HV, MV and LV) for all equipments and systems.

v) Cable routing has to be planned such that it shall not cross the steam lines, oil lines.

vi) Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.

vii) Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS

shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

viii) Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.

ix) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

x) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the Bidder without any extra charge to the Owner.

xi) Thickness of galvanizing on steel sections shall be not less than 610 gm/sq.m on all steel sections.

20.03.00 CODES AND STANDARDS

20.03.01 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on zero date. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables up to and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of practice for the protection of building and allied structures against lighting.
IS:2629	Recommended practice for hot dip galvanising of iron & steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:6745	Method for determination of mass of zinc-coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in-line connectors for aluminium conductors of insulated class.
IS:8309	Compression type tubular terminal ends for aluminium conductors of inslated cables.
IS:9537	Conduits for electrical installation.

IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints

20.03.02 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. shall also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on zero date and shall clearly bring out the salient features for comparison.

20.04.00 DESIGN AND CONSTRUCTIONAL FEATURES

20.04.01 Inter Plant Cabling

Interplant cabling for main routes shall be laid along overhead trestles/ pipe racks. However, from tap-offs, same can be through shallow trenches. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering.

20.04.02 Cable entry

Cable entry from outdoor underground/cable routes to the buildings, if any, shall be above the finished floor level of the building.

20.04.03 Trenches

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

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

iii) All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened instrumentation cables.

iv) Cable trenches shall be provided in Transformer Yard and Switchgear/MCC rooms. In other areas local cable trenches with length not exceeding 5 metres are allowed just near the equipment.

v) Two separate cable routes one on each side shall be provided for each boiler unit. Cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mils shall be routed in one route & for through other set of auxiliaries through other route.

vi) Bidder shall provide two independent routes for cables between Switchyard Control Room & Main Plant Control Room. Bidder shall provide the cable trays along with its supporting structure arrangement on the trestle.

20.04.04 Cable Vault:

i) Cable vault of not less than 3.5 metres clear height shall be provided.

ii) Clear access passage of at least 750 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways. Wherever the passage is through cable routes clear height shall not be less than 1.5 Mts.

iii) Cable vaults shall be provided with adequate drainage facility for drainage of fire water.

iv) Each cable vault should have two fire proof doors.

v) Exit signs shall be provided near doors for personnel escape in case of emergency.

20.05.00 EQUIPMENT DESCRIPTION

20.05.01 Cable trays, Fittings & Accessories

i) Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for HV, MV & LV power cables and perforated type for control & instrumentation cables. However in vertical risers ladder cable trays shall be used for control & instrumentation cables also.

ii) These shall be prefabricated hot dip galvanized sheet steel trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

iii) Cable trays shall have standard width of 600 mm, however trays with 450mm, 300mm & 150mm may be used in places considering the requirement and space constraint. The trays shall have standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.

iv) Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

v) Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 1500 mm. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/75 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.

In areas, where acid/alkalie ingration is likely (such as Battery Room, etc.) to occur, Fibre Reinforced Plastic trays with fire retardant corrosion resistance properties shall be used.

20.05.02 Support System for Cable Trays

i) Cable tray supports shall be fabricated from standard steel structures of different structures of different sizes. The sizes selected shall be adequate for the weight of cables/trays encountered.

ii) The steel members shall be cleaned thoroughly for rust and painted as follows:-

a) For indoor One shop coat of red oxide zinc chromate primer and two site coats of aluminium alkali paint.

b) For outdoor & corrosive areas like battery room – Hot dip galvanised.

20.05.03 Pipes, Fittings & Accessories

i) Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

ii) GI Pipes shall be of medium duty as per IS: 1239.

iii) Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

20.05.04 Junction Boxes

i) Junction box with IP 55 degree of protection shall comprise of a case with hinged door constructed from FRP material. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.

ii) Terminal blocks shall be of 650 Volt grade, rated for 10 A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2Cx2.5mm2 cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.

iii) The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.

iv) Junction boxes shall be of two types viz one suitable for control wiring and the other with terminals for power cable terminations. Junction boxes for power cable terminations shall have minimum nine (9) Nos. of terminals. Size of terminals shall be suitable to accommodate cables of sizes as required.

v) The junction boxes shall have the following indelible markings:-

a) Circuit Nos. on top by white-stenciled paint at site.
b) Circuit Nos. with ferrules (inside) as per approved drawing.
c) Danger sign in case of 415 V circuit.
d) Junction boxes shall be provided with two Nos. (2) earthing terminals complete with nuts and washers suitable for connection to 8 SWG G.I. wire.

20.05.05 Terminals

i) Multi-way terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

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

20.05.06 Terminations & Straight through Joints

i) Termination and jointing kits for 11/6.6 kV grade XLPE insulated cables shall be of proven design. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/6.6 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

ii) Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 6.6 kV systems.

iii) 1.1 KV grade straight through joints shall be of proven design.

20.05.07 Cable glands

i) Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful Bidder.

ii) Cable glands shall be double compression type. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE. Cable glands shall match with the sizes of different HV/MV/LV/Control cables.

20.05.08 Cable lugs/ferrules

i) The cables lugs shall be conforming to IS: 8309.

ii) Machine ferruling shall be adopted.

iii) Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

iv) The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.

v) Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types.

vi) Copper tubular terminal end for solder less crimping to copper conductors.

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

viii) Pin type lugs shall not used.

ix) Aluminium tubular terminal ends for solder less crimping of two Aluminium conductor.

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

20.05.09 Cable Clamps & Straps

i) The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

ii) Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

20.05.10 Galvanizing

i) Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots.

ii) The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

20.05.11 Welding

The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595.

20.06.00 CONSUMABLES AND HARDWARE

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

20.06.02 The materials shall include but not limited to the following:-

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

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

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

20.07.00 METHODS AND WORKMANSHIP

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

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

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

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

20.08.00 INSTALLATION

20.08.01 Cable Tray and Support System Installation

i) Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other

building structures. All cable trays shall be in vertical configuration in boiler areas.

ii) Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per relevant Standard. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant approved tray layout drawings.

iii) All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

iv) In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Bidder shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining Owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

20.09.00 CONDUITS/PIPES/DUCTS INSTALLATION

20.09.01 The Bidder shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Bidder.

20.09.02 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

20.09.03 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.

20.09.04 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be

provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.

20.09.05 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	**Spacing**
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm	3.0 M

20.09.06 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.

20.09.07 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the Bidder), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Bidder. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the Bidder at no extra cost.

20.10.00 JUNCTION BOXES INSTALLATION

20.10.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

20.11.00 CABLE LAYING AND INSTALLATION

20.11.01 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays and aligning and leveling as required shall be the responsibility of the Bidder.

20.11.02 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be

rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

20.11.03 Laying of cables directly buried in ground is not acceptable.

20.11.04 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The Bidder shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the Bidder. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

20.11.05 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.

20.11.06 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.

20.11.07 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they shall not be subjected to heat from adjacent hot piping or vessels.

20.12.00 LAYING OF CABLES IN CABLE TRAYS

20.12.01 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, Bidder shall route these as directed by the Owner.

20.12.02 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays.

Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.

- Clamps shall be of suitable sizes to firmly hold the cables of various outer diameters including tolerance in OD.
- Clamps should have been type tested for Short Circuit Withstand Test.
- For Trefoil clamps run spacing shall be 2000 mm and axial spacing shall be double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

Omega Cable clamps

- Omega clamps shall be of galvanized mild steel and shall be used to fasten the individual multi-core cables.
- Clamps shall be of simple construction, made of 2 mm thick, 25 mm wide strip of omega shape and suitable for clamping on the rungs / perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different outer diameters of cables. Omega cable clamps shall be used for individual cables above 35 mm outer diameter.
- Steel clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre
- For cables of above 35 mm OD, cables shall be individually clamped at 5000 mm interval for Horizontal runs and shall be individually clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

Strip Cable Clamps

- Strip clamps shall be of galvanized mild steel and shall be used to fasten the group of multi-core cables up to 35 mm diameter only on a full or part of the tray width.
- Clamps shall be of simple construction, made of 3 mm thick Steel, 25 mm wide strip to cover the entire width up to 300 mm wide tray and part of the tray for more than 300 mm wide trays. Strip shall have two right angle bends at each end for fixing on to the rung/ perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different sizes of tray width. However, the maximum size of clamp shall be 300 mm and for cable trays of greater width, two clamps shall be used.
- Clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre

Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Type test certificates to ascertain the strength of clamps shall be submitted for Owner's approval.
- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.

- Clamp length shall be selected such that not more than 80% of lockable length is utilised for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35 mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 35 mm OD up to 55 mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 55 mm OD) shall be 7 mm having Tensile strength 60 kg.

All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.

20.12.03 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/trays with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles.

20.12.04 Power and control cables shall be secured fixed to trays/support with arrangement described above.

20.12.05 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

20.12.06 Individual cables or small groups which run along structures/walls etc shall be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100.They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure shall result.

20.12.07 **Multi core power cables, control and instrumentation cables shall be tied and secured with nylon self locking cable ties at an interval of 5 metres when laid in horizontal trays and at an interval of 2 metres when laid in vertical trays or in cable risers (raceway).**

20.12.08 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends. The hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.

20.12.09 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of Owner.

20.12.10 Joints for less than 250 Meters run of cable shall not be permitted.

20.12.11 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Straight through joint and termination shall be capable of withstanding the fault level of 50 kA for 11/11 kV cables and 40 kA for 6.6/6.6 kV Cables. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

20.12.12 Wherever few cables are branching out from main trunk route troughs shall be used.

20.12.13 Cables shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Bidder.

20.12.14 The Bidder shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical Bidder and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the Bidder. During the erection period the Bidder shall furnish a monthly report on cable position in an approved proforma so as to keep the Owner appraised of the position.

20.12.15 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Bidder shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

20.12.16 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.

20.12.17 Separation

i) Sufficient spacing not less than 300mm shall be provided between different tiers of trays and maintained to permit adequate access for installation and maintenance of cables.

ii) At least 300mm clearance shall be provided between:
- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

20.12.18 Segregation

i) Segregation means physical isolation to prevent fire jumping.

ii) Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

iii) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives

and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

20.13.00 CABLE FIRE SEALING

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

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

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

20.14.00 Cable laying in trenches

20.14.01 RCC cable trenches with removable covers shall be provided by the Bidder for areas as mentioned in Cl 1.35.00 of Chapter - 1.

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

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

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

20.14.05 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.

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

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

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

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

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

i) 1 cable in pipe - 53% full
ii) 2 cables in pipe - 51% full
iii) 3 or more cables - 40% full

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

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

20.15.00 CABLE IDENTIFICATION

20.15.01 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables.

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of aluminium.
- Cable numbers shall be engraved type
- Tags shall be of durable quality of size 60 mm x 12 mm with a tie hole at each end.
- Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

20.15.02 If laying of underground cable is specifically agreed by Owner as a special case then the underground cables shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not

more than 30 M for straight run and at cable joint locations with additional inscription `Cable Joint'. For buried cables the marker shall project 150mm above ground.

20.15.03 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

20.16.00 CABLE TERMINATIONS & CONNECTIONS

20.16.01 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer'' instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Bidder shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

20.16.02 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Site Engineer.

20.16.03 Responsibility of proper termination shall lie on the Bidder. Guarantee for termination shall also have to be given by the Bidder.

20.16.04 The equipment shall be generally provided with undrilled gland plates for cables/conduit entry. The Bidder shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

20.16.05 Bidder shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the Bidder at the discretion of the Engineer- in-Charge.

20.16.06 Control cable cores entering control panel/switchgear /MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

20.16.07 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' along with cable numbers and coiled up after end sealing.

20.16.08 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

20.16.09 It is the responsibility of the Bidder to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.

20.16.10 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

20.16.11 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.

20.16.12 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

20.16.13 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Bidders shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

20.16.14 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.

20.16.15 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

20.16.16 In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

20.16.17 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

20.16.18 Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.

20.16.19 Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

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

20.16.21 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall

be carried out with approved sealing compound having fire withstand capability for at least three hours.

20.17.00 Cable accessories for H.V. Systems

20.17.01 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

20.17.02 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the Bidder or the type of cables issued by Owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kid.

20.17.03 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

4.1.1 i) Termination kits shall be 'Push on type' or 'heat shrinkable type'.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

20.17.04 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of Owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

20.18.00 CLEANING UP OF WORK SITE

20.18.01 The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

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

20.19.00 QUALITY ASSURANCE PROGRAMME

20.19.01 Bidder shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

20.20.00 TESTS

20.20.01 Routine / Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

20.20.02 Galvanizing Tests

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

ii) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.

iii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.

iv) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

20.21.00 WELDING

20.21.01 The quality of welding shall be visually inspected, particular attention being paid to the following points:-

i) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.

ii) The weld metal shall be properly fused with the parent metal without undercutting.

iii) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.

iv) Physical and dimensional checks for all items.

v) All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.

vi) All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.

vii) Deflection test cable trays.

viii) All acceptance and routine tests on Junction boxes.

ix) Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:-
a) Physical and Dimensional checks

b) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
c) Check chemical composition of brass parts for cable glands.
d) Hardness check on gaskets.
e) Test for uniformity of galvanization.

20.22.00 CABLE TRAYS / SUPPORTS AND ACCESSORIES

20.22.01 Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.

20.22.02 Check for continuity of cable trays over the entire route.

20.22.03 Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.

20.22.04 Check for earth continuity and earth connection of cable trays.

20.22.05 Bidder shall submit the following minimum drawings and documents for approval during detail engineering stage.

- General arrangement drawings
- Technical data sheet
- Test reports
- Installation details for junction boxes
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SECTION – 24: EARTHING & LIGHTNING PROTECTION

24.01.00 GENERAL

This specification is intended to cover the design, engineering, manufacture, assembly, testing at manufacturer's works, supply in properly packed condition for transport to site and delivery Grounding and Lightning system complete with all accessories for efficient and trouble-free operation of 2 x 800 MW Supercritical Coal Based UppurThermal Power Project in Ramnathapuram District, Tamil Nadufor TANGEDCO.

24.02.00 CODES AND STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments. All work shall be carried out as per the following standards/ codes as applicable.

CODE	NAME OF STANDARD
IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables up to and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of Practice for the protection of building and allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron & steel
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3043	Code of practice for Earthing
IS:3063	Fasteners single coil rectangular section spring washers.
IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in- line connectors foraluminium conductors of insulated cables

IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels – recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 6.6kv upto and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type, for Aluminum conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.
	National Electrical Code, 1985.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, VDE etc. shall also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Biddershall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments.

24.03.00 GROUNDING & LIGHTNING PROTECTION

24.03.01 General

The main objectives of grounding system are to:

a) Provide safety to personnel from contact of dangerous potential caused by ground fault.
b) Ensure sufficient grounding current for effective relaying.
c) Stabilize circuit potential with respect to ground.
d) Contractor shall carry out earth resistivity test of power project site within battery limit and shall establish homogeneous soil resistivity for earthing design. Number of earth resistivity test locations shall be not less than 15. The test locations shall be subject to Owner's approval.

24.03.02 Grounding system

i) In order to meet the above objectives, ground grid mesh shall be provided for the entire area within battery limit.

ii) Fault current for the earthing system shall be designed for 50 KA for duration of 1 sec.

iii) All electrical equipment, non-current carrying metal parts, structures, building steel, lightning protection system, transformer neutrals shall be connected to this station ground grid.

iv) Treated earth pits including riser shall be provided for Transformer neutral earthing.

v) Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

vi) Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.

vii) The major aspects to be considered for grounding system design are given below:

24.03.03 Ground Grid Conductor

i) Ground grid conductor of mild steel rod shall be used.

ii) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.3 mm (on diameter of conductor) per year over the design life of 40 years.

24.03.04 Underground Grid

i) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80.

ii) The ground grid conductors shall be buried in earth at a depth of 600 mm. However suitable precaution to be taken wherever under ground drains / Trenches are passing through it. The length of ground conductors below earth shall be sufficient to ensure a ground resistance less than one (1) ohm for each area/building.

iii) The ground grid conductor shall be so laid as to provide short and direct connection to building steel and major electrical equipment.

iv) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.

v) All ground grid conductor connections shall be welded type.

vi) Earth mat of each area/building (ie Main Plant Building, Transformer Yard, Sevice Building, DG Building and CPU Regenration building etc) shall beinterconnected with the earth mat conductor of the neighbouring area at atleast two (2) points for further reducing the ground grid resistance.

vii) A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes,

foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

viii) In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

ix) Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.

x) Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.

xi) The Bidder shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc.

24.03.05 Ground Electrode

Ground electrodes shall be 40 mm dia. and 3 metre long M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductors. All connections to the conductors shall be done by arc welding process.

24.03.06 Above Ground Connections

i) Galvanised steel flats shall be used for all connections above earth.

ii) Inside building, ground conductors shall be run for each floor supported on building steel and/or cable trays. These ground conductors in turn shall be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.

iii) Two separate and distinct ground connections shall be provided for each electrical equipment in compliance with I.E. Rules.

iv) Allconnections above ground shall be welded type except connection to equipment/structures which shall be bolted type.

24.03.07 Column Grounding

All steel columns and structures shall be connected to the earth mat through 40 mm dia M.S. rods. All welded joints shall be painted to protect from rusting.

24.03.08 Risers

Risers are required for connecting the equipment and structures with the ground mat. Risers are to be provided from underground mat to above ground levels where the ends shall be left free for connecting to the equipment. Each riser

shall be 1 No. 40 mm dia. M.S. rod and shall project above grade level/concrete floor level by minimum 300 mm. They are to be clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding.

24.03.09 Equipment Ground Lead

i) Equipment ground connections shall be sized to carry the ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.

ii) The minimum ground conductor sizes for various equipment and structures are given in below.

DESCRIPTION	**SIZE**	**MATERIAL**
a) Main Grounding Grid Conductor	40 mm dia Rod	Mild Steel
b) Riser/Pigtail From GroundingGrid/Mat	40 mm dia Rod	Mild Steel
c) Electrode	40 mm dia,3000 mm long Rod	Mild Steel
Conductor used for connection of various equipment/structures as listed below		
i) TGs, GTs, UATs and IPBD	75 x 10 mm	GI Flat
ii) Transformer body	75x10 mm	GI flat
iii) 11 kV &6.6 kV Switchgears, Motors	75 x 10 mm	GI Flat
iv) 415V Switchgear, MCCs, Battery Charger, distribution Boards	75 x 10 mm	GI Flat
v) Sub-mat	75 x 10 mm	GI Flat
vi) 415 Motors		
1) Above 100 KW upto200 KW	75x10 mm	GI Flat
2) Above 55 KW upto 100 KW	40x6 mm	GI Flat
3) Above 22 KW upto 55 KW	40x6 mm	GI Flat
4) Above 5.5 KW upto 22 KW	25 x 6 mm	GI Flat
5) Upto 5.5 KW	4 SWG	GI Wire
vii) Cable Trays	40 x 6 mm	GI Flat

viii) Control Panel & Control Desks etc.	40 x 6 mm	GI Flat
ix) Steel Column	75 x 10 mm	GI Flat
x) Fence and Gate	40 x 6 mm	GI Flat
xi) Push Button Stations	8 SWG	GI Wire
xii) Lighting panel, Junction Boxes	4 SWG	GI Wire
xiii) System neutrals (for service transformers)	1Cx400 sqmm	XLPE cable
xiv) Lighting Fixtures & Receptacles	14 SWG	GI Wire
xv) Welding Outlets	8 SWG	GI Wire
xvi) Rails	40 x 6 mm	GI Flat

iii) 75 x 10 mm galvanized steel flats(minimum size) shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing. These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground. Earthing conductors along their run on column, wall etc. shall be supported by suitable welding/clamping at intervals set exceeding 750 mm.

iv) Earthing conductors can be embedded in concrete floor of the building wherever necessary without having direct contact with the reinforcement rods. At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

v) All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.

vi) Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.

vii) Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends.

viii) A continuous 40 x 6 mm (minimum size) G.S. flat earthing conductor shall run along the cable trays and supporting structure of all cable

routes. This earthing conductor shall be attached to each section of cable tray/trays through 40 x 6 mm G.S. flats. The earthing conductor shall be securely connected to the earth mat at both ends.

ix) Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement.

x) The street lighting poles, junction boxes mounted on the poles, flood light supporting structures etc. shall be connected to ground grid at minimum two points.

xi) The steel columns, metallic stairs, hand-rail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.

xii) The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.

xiii) The overhead crane rails shall be grounded at both ends. In addition all joints shall be bonded to provide electrical continuity.

xiv) The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.

xv) The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

24.03.10 Jointing and Connection

i) All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.

ii) The bending of the large diameter ground conductor where necessary shall be done by gas heating.

iii) The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

iv) The connections between the riser/pigtail and earthing conductors (galvanized steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.

v) The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint

after welding.

vi) The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GI bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

vii) Equipment/structures ground connections shall be coated with weather resistant paints/cold galvanizing paints after proper checking / testing.

viii) Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

24.04.00 Earthing of cabling system

- Armour of the HT cables and LT single core cables shall be earthed only at one end of cable.
- Armour of other cables shall be earthed at both ends of cable.
- Screen of HT power cables shall be earthed at one end only.
- Screen of C&I screened control cables shall be earthed at one end.
- Screen of electronic earthing system cables shall be earthed as per the requirements.

After completion of grounding system installation, the measurement of ground resistance shall be performed by the Contractor. continuity of earth conductors and efficiency of all bonds and joints shall be checked.. The method of measurement shall be as per relevant standards / codes. The ground resistance of system shall be not more than 0.5 ohm. Earth resistance at earth terminations shall be measured in presence of Owner's representatives

24.05.00 General:

i) Electronic earthing shall be provided as per relavent International standrard for all control systems (such as DDCMIS, PLC , SAS, EDMS etc.,) For electronic equipment chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 40 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 4000 mm depth. The pit shall be effective in all weather conditions and offer medium resistance. For electronic earthing system, earthing conductor shall be of copper

ii) Neutral of Service transformers shall be earthed through minimum of 400 sqmm single core cable through two numbers treated earth pit and inturn shall be connected to station earth grid.

iii) LV Neutral Points of the following transformers shall be connected to Neutral Grounding Resistors (NGRs). NGR shall be connected to earth through two numbers treated earth pit.

- Unit transformer

- Station Transformer
- Unit auxiliary transformer
- Station auxiliary transformer
- Other auxiliary transformers

iv) Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

v) Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

vi) Earthing conductors along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 1000 mm. Wherever it passes through walls, floors etc., pipe sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

vii) Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.

viii) Electronic panels and equipment shall be grounded utilising aninsulated copper ground wire terminated at separate earth electrode.

24.06.00 Lightning Protection System

i) The main purposes of lightning protection system are to:

a) Provide protection to structures from lightning strokes.
b) Provide a low resistance-conducting path to lightning discharge.

ii) Lightning protection shall be provided as per IS: 2309 for the structures, equipments and buildings within the battery limit.

24.06.01 System Design

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

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

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

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

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

v) Galvanised steel rods and flats shall be generally used for air termination and

connections. All connections shall be welded type.

vi) The lightning protection system in the transformer yard shall cover the following equipment in the protection zone.
- Generator transformers
- Station transformers
- Standby transformers
- Auxiliary transformers

vii) All areas of the power station shall be provided with lightning protection. The lightning protection system for buildings shall consist of air termination network, down conductors, test link and earth electrodes.

viii) Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.

ix) For Lightning protection, material Thickness of galvanising shall be atleast 610 gm/sq.m for all galvanised steel conductors.

x) The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical equipment, underground metallic ducts etc. All metallic structures within vicinity shall be bonded to the lightning protection system.

xi) All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.

xii) Lightning conductor when used above ground level and shall be connected through test link with earth electrode/earthing system. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.

xiii) Each down conductor shall be provided with a test link at 1500 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be of welded type.

xiv) Down conductors shall be cleated on outer side of building wall/ welded to outside building columns at 750 mm interval.

xv) Lightning conductor on roof shall be cleated on surface of roof using insulated clamps/saddles for conductor fixing at an interval of 1000 mm for horizontal run and 750 mm for vertical run.

xvi) Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

xvii) Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.

24.06.02 Air Terminations

i) The vertical air terminal rods shall be installed at the roof of buildings for MCC/Switchgear rooms, ESP Control rooms etc to protect these objects from lightning strokes.

ii) The projected length of the Air termination rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

iii) The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.

iv) All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 50 x 6 mm galvanized steel flats.Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rod shall be more than nine (9) metres from the nearest roof conductor.

24.06.03 Shielding Masts

i) The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of the associated building.

ii) The shielding mast shall be made of galvanized steel rod and the height of the same shall be decided considering the zones to be protected.

iii) Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm minimum. Galvanised steel flat run along the building column. In addition all building columns joints shall be electrically bonded.

24.06.04 Down Conductors

i) Galvanized steel down conductors of suitable size shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.

ii) Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.

iii) The connection between each down conductor and rod electrode (by means of 40 mm mild steel rod riser) shall be made via test link located

at approximately 1500 mm above ground level.

iv) The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleared on outside of the building wall and column/structure at about 750 mm intervals unless stated otherwise in the drawing.

v) At all supports for down conductor along the column/wall of the buildings etc. the portion embedded inside the building concrete should not touch the reinforcement bars.

vi) All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

vii) The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

24.06.05 Electrodes (for Lightning Protection)

i) The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.

ii) All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which shall be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

24.06.06 Riser (for Lightning Protection)

All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.

24.06.07 Jointing & Connection

i) All ground conductor connections below ground level shall be done by electric are welding with low hydrogen content electrode.

ii) The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

iii) The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

iv) All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.

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

vi) The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

vii) The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

viii) The steel to copper connection shall be brazed type.

ix) The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

x) The sizes and materials of earthing conductors to be used in lightning protection system are listed below:-

DESCRIPTION	SIZE	MATERIAL
1) Horizontal air termination and down conductors for buildings, boilers and other tall structures.	25 x 6 mm	GI Flat
2) Vertical air termination rods for other buildings / tanks etc.	20 mm dia 1000 mm long	MS rod

Note: The above sizes are indicative only. Actual size shall be arrived at as per design by the Bidder.

24.07.00 DRAWINGS & DOCUMENTS

Bidder shall submit the following minimum drawings and documents for approval during detail engineering stage:

- Soil resistivity report
- Design basis report for earthing and lightning protection system
- Earthing design calculation
- Typical installation drawings for earthing and lightning protection
- Electronic earthing layout and details
- Earthing layout for Transformer Yard
- Earthing layout for Power house building, Boiler and ESP
- Earthing layout for all auxiliary plant buildings
- Earthing layout for all non-plant buildings
- Lightning protection design calculation
- Lightning protection layout for Power house building, Boiler and ESP
- Lightning protection layout for transformer yard
- Lightning protection layout for all auxiliary plant buildings
- Lightning protection layout for all non-plant buildings
- Field quality plan

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		

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

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

ANNEXURE-II

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	425	ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE	2X800MW UPPUR STPP	NAME		DATA FILLED UP ON	
	SYSTEM	MILL REJECT SYSTEM	SIGN.		DATA ENTERED ON	
	DEPTT. / SECTION	MAX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

CABLE SCHEDULE FORMAT ANNEXURE III

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

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

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

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

(A) SYSTEM VOLTAGE CODES:

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

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

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

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

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

SUB-VENDOR LIST FOR LT MOTORS

SL NO.	VENDOR NAME	
1	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003
2	BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.
3	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA
4	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032
5	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055
6	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA
7	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006
8	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045
9	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053
10	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA

SUB-VENDOR LIST FOR GLANDS

1	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA
2	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068
3	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018
4	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063
5	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.
6	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059
7	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001

SUB-VENDOR LIST FOR LUGS

1	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.
2	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001

SUB-SECTION – IC

SPECIFIC TECHNICAL REQUIREMENTS (C&I)

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TECHNICAL SPECIFICATION (CONTROL AND INSTRUMENTATION) FOR MILL REJECT SYSTEM (MRS)

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INDEX

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Specific Technical Requirements (C&I):

1. Control of Mill Reject Handling System is envisaged through main plant DCS (BHEL Scope) placed in Central Control Room. Integral microprocessor based controller of MRS Compressor (mounted on compressor skid itself) shall be interfaced with main plant DCS through H/W (start & stop operation only) and redundant soft interfacing (not in daisy serial link) soft link.
2. The Contractor shall provide complete Instrumentation & Local control panels for control, monitoring and operation of Mill Reject Handling system & Air compressors for Mill Reject Handling system. Also, Contractor shall provide MP based control system for control, monitoring and operation of Compressed Air system of MRHS.

3. The controls for MRHS shall be realized in DDCMIS based control system (DDCMIS not in Bidder's scope) & Air compressors for MRHS shall be MP based. MP based panels for Air Compressors shall have a provision for soft as well as hardwired interface with DDCMIS. The overall control of MRHS & Air compressors for MRHS shall be from DDCMIS. Contractor to consider hardwired remote start/stop, hardwired feedbacks for Compressor On, off & Trip & loading/unloading of Air compressors from MP panel to DDCMIS as a minimum.

4. List of signals to be exchanged between MP & DDCMIS shall be furnished by Contractor during detailed engineering in the signal exchange list format.

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

6. In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.

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7. The make/model of various instruments/items/systems shall be as per customer approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

8. All instruments shall be terminated on JB in field and both instrument and JB are in bidder scope.

9. RF Type level switches/transmitter shall be provided for interlock & monitoring purpose on transport vessels & Bunkers.

10. Bidder to provide mandatory spares as per mandatory spares list.

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

12. Scope of Instrumentation cables (Screened Control Cables) & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification.

13. The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering.

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

15. The quantity of instruments for the system shall be as per tender P &ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

16. Bidder to terminate all instrumentation and control elements in junction boxes. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics / write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.

17. All the transmitters supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply. All transmitters shall be HART compatible. Only two wire transmitter shall be used.

18. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication.

19. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyzer installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.

20. All Temperature sensors shall be Duplex type and temperature transmitter shall be for monitoring services/application only.
21. Bidder to furnish electrical load/UPS load data during detailed engineering.

22. Bidder to provide temperature transmitter, JB/Rack & other erection hardware.

23. 230 V AC UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Bidder to submit the power requirement along with the bid.

24. Bidder’s presence is required for 3 Man days (Excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation to attained FAT shall be informed in 2

days advance. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

25. Contractor's C&I representative shall be present at BHEL-PEM for 3 man-days, for preparation of Control scheme of MRHS. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

26. Bidder's presence is required for 15 Man days (in three visit) at site during commissioning of DDCMIS for assistance related to process correctness. Three visit with total 15 Man days (Excluding travel time) in which one visit shall be of 5 Man days each. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

27. Interface of MCC, LT SWGR, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

28. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V Dc only.

29. All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless otherwise specified.

30. Redundancy of sensors/signals/ measurement shall be provided by bidder

    i. Triple redundancy (2 out of 3) is required for critical control and protection (analog & binary) applications & services.
       a. Triple redundancy for all trip logics.
       b. Triple redundancy for all HT drives (fed by 3.3kv onwards) trip, protection & auto start.

       All corresponding temperature & pressure compensating measurements shall also be triple redundant only.

    ii. Dual redundancy (1 out of 2) is required for all control & interlock (analog &binary) application and services.
       a. Dual redundancy for all LT drives trip, protection & auto start.
       b. Dual redundancy for critical monitoring application.

31. Number of pairs to be selected for Screen /Control cable (Size: 0.5 mm2)

    a. F-Type: 2P/4P/8P/12P/20P

b. G-Type: 2P/4P/8P/12P

c. Core Cable: 3CX2.5sqmm2/ 12CX1.5sqmm2

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SPECIFICATION FOR MEASURING INSTRUMENTS (PRIMARY & SECONDARY), TRANSMITTERS, GAUGES ETC. AND LOCAL CONTROL PANEL

CHAPTER-3

FIELD & MEASURING INSTRUMENTS AND FLOW ELEMENTS

3.00.00 FIELD & MEASURING INSTRUMENTS (PRIMARY & SECONDARY INSTRUMENTS) AND FLOW ELEMENTS

3.01.00 GENERAL REQUIREMENTS

3.01.01 Field Instruments, control devices, remote instruments, Flow Elements 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 In general, front draw out type instruments with plug-in facility at the rear for connecting cables for power supply and signal shall be provided unless otherwise specified like for Explosion proof area, Flame proof area and high vibration prone area. Separate plugs & socket connection shall be provided for connecting power supply cables and signal wires/cables.

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 and 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 1/2, Division 1 area & flame proof area) 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 (SS316 materila), nuts & bolts etc. 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 else where 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 (Type as per Owner Approval) for sump/tank/vessel/containers/heaters/hoppers/silo level very high/high/normal/ low/very low interlocks.

iii. Level Transmitters (Type as per Owner approval) for open sump/ tank/bunker/vessel/heaters/containers/silo etc. in addition to level switches.

iv. Stand pipes on both side of tank for all level instruments (LT, LS & LG).

v. Flow elements (Type as per Owner Approval) with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, Lube oil, open channel liquid, solid fuel, ash flow, ash slurry, DM water, PT plant, ETP Plant, Raw water, Instrument and Service air etc. as decided by owner with in terminal points and scope.

vi. Pressure gauges, temp. Gauges and Temp. Element 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, hardwares & JBs etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JBs etc used for measurement for Hydrogen Gas & Oxygen Gas shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.

x. All Thermocouples & RTDs (Type as per Owner Approval) shall be Duplex. Thermocouples shall be provided for Mill outlet temperature and for Services with Temperature $\geq$ 200 deg C.

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 All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

xv All limit switch shall be conform to IEC-60947-5-1 and shall have minimum 2SPDT/DPDT contacts.

xvi 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.

xvii. On both left and right sides of furnace, separate lines shall be laid and provided with **furnace pressure transmitters having wide range** than the furnace pressure transmitter used for modulating Control.

xviii. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services/application only. However any RTD & Thermocouples are used for control, interlock & protection application, Metal Temperature, and bearing & winding temperature, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.

xix. As for the water flow/ steam flow measurements, **necessary flow elements/ transmitters are chosen in the process line and supplied such that their algebric summation shall be mass balanced for calculating the system efficiency**.

xx. Non Contact Type, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.

xxi. For Turbine oil tank, LDO/HFO tank, DM water tanks, CS tank, Chemical dosing tanks, Acid and alkali applications, lube oil tanks, and any other tank/sump etc., only non contact type level transmitters like Acoustic, Ultrasonic, Radar based (Type as per Owner Approval) shall be provided by bidders as specified in the specification and as approved by owner.

xxii. 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. xxi, in case used for monitoring only. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wirelss transmitters shall have the same minimum specification/parameters as mentioned for wired transmitters.

xxiii. For Turbine oil, HFO/LDO applications & H2 Gas application, zener protection on power supplies shall be included.

xxiv. 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.

xxv. Gauges (all type) for local monitoring in field.

xxvi. Each switching element including the limit and torque switches of valve actuators shall be provided with minimum two contacts i.e. 2SPDT OR DPDT.

xxvii. All instruments should be supplied with valid calibration and test certificates provided by OEM.

xxviii. Canopy/Enclosure shall be provided for field instruments like transmitters, switches & flow meters, etc and any other equipment to protect from direct sun light, lightining & rain.

3.03.00 FIELD INSTRUMENTS AND PANEL MOUNTED INSTRUMENTS SHALL BE SUPPLIED & OFFERED AS PER DATA SHEETS SPECIFIED BELOW:-

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 For Hydrogen gas pressure/differential pressure transmitters, the suitable material and coating shall be chosen as per the suggestion of transmitter manufacturer.
- Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 m 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 $\pm$ 0.2% or better of span for remote seal type transmitter.
Turn down ratio	:	100:1 in general 30:1 or better of Span for very high pressure & very low pressure services.
Stability	:	$\pm$ 0.15% of URL for 10 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)/Flame proof (IEC – 79.1, Part I).
Span and Zero	:	Locally adjustable, non-interacting
Zero suppression / elevation	:	At least 100% of Span
Connection		
- Process		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.
IBR Requirement	:	For high pressure & high temperature service, Process tapping and root valves shall be as per IBR rules and regulations.
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

Requirments for flanged remote seal diaphragm:

Maximum pressure rating : To meet 200 percent of process pressure

Availability of seals : for both high and low pressure sides with capillary connection in case of differential pressure transmitters and

Single Capillary connection for pressure transmitters.

Capillary length : 6.0 m

Fill fluid : Suitable oil

Process connection size : 1 inch

Flange size and Accessories : As per process requirement.
Flange pressure rating : Required Class (ANSI)
Process liquid : Sea water, Ash water, chemical, hydrogen gas, sealoil etc.,

Process fluid temperature : 25°C to 60°C

Diaphragm and wetted part material : Suitable for sea water, ash water and chemical applications.(offered material to be specified)

Flushing option : To be made available with 1/4 inch (necessary drain and gasket suitable for sea water application to be provided)

Transmitter should not be mounted directly on the manifold, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampners 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, smart positioner & other HART based instruments shall be supplied ~~along with 4 Nos. of universal type hand held/portable calibrators per unit.~~ Temperature ~~transmitters shall be supplied along with 4 Nos. of hand held/portable mV source generators per unit.~~
If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

Following minimum accessories shall be provided with each set:-

i. Soft carrying case with adjustable shoulder straps & lead compartments.
ii. HART lead set.
iii. Rechargeable batteries.
iv. Battery charger.
v. Power adaptor.
vi. Universal plug kit for power adaptor.
vii. Load resistor.
viii. Interfacing cables of each type as per requirements.
ix. Protective boot.
x. Standard banana jack.
xi. Operation manual & software CD.
xii. Analysis & Diagnostic Software.

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
- Enclosure	:	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 of full range.
Repeatability	:	$\pm$ 0.5(half) percent or better of full range.
Setting & Differential	:	Adjustable
Dead Band	:	Adjustment up to 10% at set point.
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 terminated inside the switch. Cable ends are to be soldiered 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-1/2, Division 1 area)/Flame Proof (IEC – 79.1, Part I) as applicable.
IBR Requirement	:	For high pressure service, Process tapping and root valves are as per IBR rules and regulations.

Accessories

- 3 / 5 valve manifold	:	As applicable depending on type of 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 only).

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/cm2	:	Bellows/Diaphragm
-Above1.0Kg/cm2	:	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 toughened shatter proof glass. 300 mm with toughened shatter proof glass for frame mounted gauges.
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	:	± One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local / Frame mounted.
	:	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)
IBR Requirement	:	For high pressure service, Process tapping and root valves are as per IBR rules and regulations.

Accessories

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

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device		
Ranges 5 to 20 Kg/cm2	:	Rubber blow out disc with open front construction.
Ranges above 20 Kg/cm2	:	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 and DM water storage tanks, 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 **Temerature Transmitters (TT)/Differential Temperature Transmitters (DTT)**

Type	:	Dual Input, SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display).
Accuracy	:	± 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 1/2 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316
Stability	:	± 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
EMC compatibility	:	As per EN 61326
Operating Ambient Temperature	:	0 to 70 deg C.
Mounting	:	Head Mounted/locally mounted as per application finalized by owner.

Temperature Transmitters shall not be used for CLCS, OLCS, interlock & protection services anywhere in the plant with RTD & Thermocouples. However RTD & Thermocouples are used for control, interlock & protection application, same shall be

directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.

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

For BFPs' differential temperature protection by 2 out of 3 logic, DTT shall be employed to deliver 4-20 mA output to DDCMIS using suction & discharge temperature measurements.

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

These transmitters shall be connected with duplex sensors and shall have bump less change over facility to second sensor in case first sensor fails .This change-over is to be alarmed.

Temp. Transmitter shall be extremely stable against Ambient temp variation, The accuracy figure shall be inclusive of effect due to ambient temperature variation.

Considering the monitoring application & distance involved for monitoring parameters **wireless technology** shall be adopted by interfacing with DDCMIS through OPC connectivity. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wirelss transmitters shall have the same minimum specification/parameters as mentioned for wired transmitters.

3.03.05 RESISTANCE TEMPERATURE SENSORS WITH THERMOWELLS

Applicable Standard	:	ASME PTC 19.3 - Latest Revision DIN EN 60751:1996, BS EN/IEC 60751: 2008
Element	:	Platinum, R0=100 ohm 4-wire Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
Sheath Material/ Insulation	:	316SS/Compacted Magnesium Oxide with high purity of 99.4% minimum.
Sheath O D	:	8 MM
- Gauge	:	18 AWG
Terminals	:	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
Calibration	:	As per DIN Standard – 43760/IEC 60751, Class A.
Head	:	Hex Head, Die Cast Aluminum (Screwed)

		with galvanized SS chain
Response Time	:	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
Accuracy	:	± 0.35 degree C or Class-A whichever is better.
Instrument Connection	:	1/2 " NPT (F).
Electrical connection	:	Gold plated Plug in type. Double entry – one unused entry with blind plug
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1/2, Division 1 area)/Flame proof (IEC – 79.1, Part I) as applicable.

THERMOWELL

Applicable Standard	:	ASME PTC 19.3 TW - 2010
- Construction	:	Tapered drilled from Bar stock (Straight for Air & Gas systems)
- Material	:	- 316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. - Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges. For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010. "All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells". For sea water, better material like super duplex SS shall be provided.
- Process Connection	:	(i) M 33 x 2 / Rc 1-1/2" (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends.
Immersion length	:	Within ± 10 mm of center line of pipe and as per ASME – PTC-19.3 - 2010
Extension neck length	:	Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
IBR Certification	:	For high pressure service, Steam

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

Note : **i. Extension /**Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB. The head shall be more than 300 mm above the top of mill.

ii. In case, Duplex RTDs are not provided by bidder due to system/equipment limitation, two no. simplex RTD shall be provided instead of Duplex RTD. Both Simplex RTD shall be terminated at local JB/Termination Box.

3.03.06 THERMOCOUPLES WITH THERMOWELLS

Applicable standard	:	ASME PTC 19.3- Latest Revision ANSI-MC 96.1 – 1982, IEC 584-2
Element	:	Duplex
- Sheath	:	8 MM OD
- Sheath Material	:	316 SS
- Spring Loaded	:	Yes
- Nipple/Union	:	Yes
- Packed connector	:	Compacted magnesium Oxide
- Hot Junction	:	ungrounded
- Type	:	i. Type K (Chromel - Alumel) ii. Type S/R (Platinum Rhodium-Platinum) iii Type T (Cu-CuNi) with special limits of error according to ANSI-96.1 - 1982.
- Gauge	:	18 AWG
Head	:	Die Cast Aluminum
Terminals	:	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
Instrument Connection	:	1/2 " NPT (F).
Electrical connection	:	Gold plated Plug in type. Double entry – one unused entry with blind plug
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1/2, Division 1 area)

Thermowell

- Construction	:	Tapered Drilled from Bar stock (Straight for Air & Gas systems)
- Material	:	- 316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. - Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges. For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance. For sea water, better material like super duplex SS shall be provided. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010. "All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells".
- Process Connection	:	(i) M 33 x 2 / Rc 1-1/2" (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, gaskets, fasteners etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Accuracy (Special Class as per IEC-751/ANSI-C-96.1)

(For Type K T/C)	:	$\pm$ 1.1 deg.C (for 0 to 277 deg.C) $\pm$ 0.4 percent (for 277 to 1280 deg.C) Class-A
For Type S & R T/C	:	$\pm$ 0.6 deg.C or $\pm$ 0.1% , whichever is greater.
For Type T T/C	:	$\pm$ 0.5 deg.C or $\pm$ 0.4%, whichever is greater.
Accessories	:	Bolts, nuts and gaskets for flanged connections.

Response Time (Bare Thermocouple)

- For SH & RH Temp. Control	:	4-6 Sec.
- All other applications	:	10 Sec.

Immersion length	:	Within ± 10 mm of center line of pipe and as per ASME – PTC-19.3 - 2010
Extension neck length	:	minimum 100 mm above insulation of Pipe and minimum 160 mm when there is no insulation on pipe.
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations.
Note	**:**	**i. Extension/**Compensating cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB. The head shall be more than 300 mm above the top of mill.

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

iii. CJC Boxes are not required, Thermocouple cables shall be directly terminated at Thermocouple I/P cards only.

iv. Bidder may also provide Triplex Thermocouples as per process requirements.

3.03.07

Measuring Medium	:	Metal Temperature
Material of Thermocouple.	:	Chromel Alumel Type K
Type of Thermocouple	:	Duplex with separate hot junctions, ungrounded
Insulation	:	Mineral Insulation Magnesium Oxide.
Thermocouple wire gauge	:	16 AWG
Protective sheath	:	SS 321
Protective sheath dia	:	8 mm O.D
Characteristics of Thermocouple	:	Special limits of error as in ANSI thermocouple MC 96.01.1975

Mounting accessories	:	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310.
Cold end sealing	:	SS pot weal with colour coded PTFE headed sleeve Insulated flexible tails. Sealing compound- Epoxy resin.
Minimum bending radius	:	30 mm
Length of T/C	:	30 Mtr. (minimum)
Enclosure Class		IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

3.03.08 TEMPERATURE SWITCHES (TS)

Type/Construction

- Switch	:	Industrial type inert gas filled with capillary and separable thermowell and contacts directly connected to Bourdon element/vapor pressure sensing, gas filled bellows type preferred.
- Thermowell	:	Bar stock

Material

- Bulb	:	316 SS
- Capillary	:	Armored Stainless Steel
- Bourdon/bellows	:	316 SS
- Bourdon Movement	:	SS 316
- Casing	:	Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
Setting and Differential	:	Adjustable
Accuracy	:	$\pm$ One (1) percent of setting and differential
Repeatability	:	One half(1/2) percent of setting.

Contacts

- 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

Pipe	:	M33 x 2
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Instrument Connection	:	1/2 " NPT (F).
Thermowell	:	To suit Temp. switch with same design criteria as specified for RTDs.
Electrical	:	Suitable for Plug in type. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
Enclosure Class	:	IP-65 or better/ (Explosion/Flame proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Other Particulars		
- Capillary length	:	As per requirement (min 10 meters)
- Immersion Length	:	Within $\pm$ ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Packing glands	:	Yes
IBR Certification	:	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
N.B	:	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

3.03.09 TEMPERATURE GAUGES (TG)

Applicable standard	:	IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification
Type/Construction		
- Thermometer	:	Industrial type, Gas in Filled type with separable thermowell
- Thermowell	:	Bar stock3d
Material		
- Bulb	:	316 SS
- Capillary	:	Armoured SS (Applicable for capillary Type)

- Casing	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
Dial Size	:	150mm with shatter proof glass
Scale Details	:	270 degree dial rotation/deflection. Graduations in black lines on white dial 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
Response time	:	Maximum 15 seconds without thermowell and 30 seconds with thermowell
Connection		
- Pipe	:	M33 x 2
- Thermowell	:	To suit instrument with same design criteria specified for RTDs.
- Process Connection	:	(i) M 33 x 2 / Rc 1-1/2” (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Other Particulars		
- Capillary length	:	5Meters/10 Meters as required
- Immersion Length	:	Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Stop at Maximum value	:	For all gauges of scale
- Pointer	:	Externally adjustable
	:	In general, Contact type Temp. gauges are not acceptable for interlock & protection. Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. only.
- Over range protection	:	150 percent (%) of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

IBR Certification	:	For high pressure service, Steam 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 SS 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 from UPS / 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

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 ºC.
Mounting	:	Wall / Surface
Supply voltage	:	UPS 240V AC, 50Hz / 24V DC
Response time	:	100 m sec or better
Cable connection	:	¾" 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

Type	:	Guided wave Radar (Contact type)/Radar (Non contact type) as finalized by owner.
Application	:	For HP Heaters, Deaerators, Turbine Lube oil tank, lube oil tanks, HFO & LDO tank level, Condenser Hotwell, LP heaters, CBD tank level, Stator water expansion level, and other Low pressure, Vacuum vessels. Also Bulb type with Teflon coating & drop antenna shall be used acid /chemical tank applications. For oil tank applications, four wire transmitter shall be supplied with zener barrier protection for power supply connected to level transmitters.
Environment Class	:	Highly abrasive with Gases and Fumes
Orientation	:	Vertical
Probe Type	:	Flexible Single lead with chuck
Probe Material	:	SS 316L
Connection Size & Type	:	2" Flanged ANSI 300 lb SS316L material
Connection material	:	SS 316L
Accuracy	:	+/- 5 mm
Resolution	:	± 1 mm
Type (Transmitter)	:	SMART, 2 Wire
Operating Principle	:	Time Domain Reflectrometry
Output	:	4-20 mA, DC with **HART protocol** and 600 Ω output load.
Electrical Connection	:	½" NPT
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Electrical Power	:	11-42 V DC
Housing material	:	Die Cast Aluminum
Vent & Drain Plug material	:	SS
Side Flange Material	:	SS
Local Display	:	Provided (LCD Digital)

Units of Measurement : Length M

Electromagnetic compatibility: EN-61326

3.03.15 3 D TYPE ACOUSTIC WAVE LEVEL TRANSMITTER

		Canopy/Enclosure:

unit. **Electronic unit shall be separate.** Head mounted electronic unit is not preferred.

ii. Mounting accessories
iii. standpipe
iv. Washer & gasket

Test pressure : Two times rated pressure

3.03.19 Capacitance Type Level Switch

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 / ¾" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Enclosure	:	Powder/Epoxy coated Die cast Aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 ºC.
Mounting	:	On Top
Supply voltage	:	240V AC, 50Hz from UPS/ 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

3.03.20 RF TYPE LEVEL SWITCH

A. Electronic Controller

1.	Input Supply	:	240 V AC from UPS
2.	Construction	:	Die Cast Aluminum/SS Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts (2SPDT)
4.	Contact Rating	:	5A at 240 V AC & 0.25 at 220 V DC
5.	Class of Protection	:	IP-66
6.	Ambient Temperature	:	55 Deg. C(Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable Connection	:	3/4" ET(2 Nos.) for Supply and Output

			5/8" ET(1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Die Cast Aluminum/SS
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted
7.	Cable Connection	:	5/8" ET(1No.)
8.	Process Connection	:	40 NB BSP THREADED

C. Signal Cable : Coaxial cable for Connection Between Sensing probe and electronic Controller(@ 10 Mtrs. Per Level Probe)

D. Application : Ash Silos

3.03.21 **LEVEL INDICATORS (Gauge Glass) (LI)**

Type/Construction	:	**a)**	**Reflex**
		b)	Tubular (For tanks open to atmosphere only)
Material:			
a) Glass	:	Tempered borosilicate resistant to thermal shock	
b) Case	:	Carbon steel	
c) Integral cocks and	:	i)	Forged carbon steel with drain valves stainless steel internals
		ii)	Rubber lined corrosion resistant 316 stainless steel (for Demineralised and Osmosis water service)
d) Fittings	:	i)	Forged carbon steel
		ii)	Rubber lined 316 steel/PVC for corrosive liquids Demineralised and Osmosis water service)
		iii)	304 Stainless Steel for non-corrosive liquids
e) Packing	:	Teflon	
Dial size/scale	:	150 mm /1.5 Meters maximum length with	
Scale details	:	Aluminum/SS316 scale Graduated in mmwc	
Connection	:	25 Nb/40 Nb ANSI Flanged	
Accessories	:	a)	Integral cocks
		b)	Drain valves
		c)	Bolts, nuts and gaskets
		d)	Illuminating lamps as required
		e)	Periscope as required

Tests	:	Tested at two hundred (200) percent of the maximum process pressure
Other details	:	For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.

3.03.22 FLOAT & BOARD TYPE LEVEL GAUGE

Type of Instrument	:	Mechanical Type (Float Operated)
Service/ Application	:	As per service requirement
Measuring Range	:	as per requirement
Material Specification		
a) Float Material	:	SS316 having 2 nos. Guide wires
b) Float Wire Pulley	:	Shall comprise of 2 nos. Cast Aluminum Pulley hosing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be SS316L. Between 2 pulleys, 1" SS short pipe.
c) Guide wire Assembly	:	SS chamber with SS316 spring and adjuster having 1" Class 150 ANSI RF SS flange. Guide wire rope shall be SS316L.
d) Counter Weight	:	MS counter – weight with Aluminum Pointer and Brass assembly Pull Chain.
e) Scale	:	SS 316/Aluminum material in mm with 1 % accuracy.
Nozzle Details	:	For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type)
Process Connection	:	Flanged as per ANSI B 16.5 to suit 1" NB nozzle (Nozzle length - 150 mm for float wire, 100 mm for guide wire)
Accessories (to be supplied with the instrument)		
a) Counter flange	:	All mating Flanges, Nozzle
b) Mounting Accessories	:	All mounting accessories
c) Tag Plate	:	To be provided (material SS316)

3.03.23 MASS FLOW METER

Sensor

Measuring Principle	:	Coriolis Mass flow.
Primary Element	:	Flow Tube of 316SS or better
Heating Arrangement	:	Integral with Flow meter.
Temperature Control For Heating	:	To be provided.
Process Connection	:	ANSI RF Flanged and rating as per process requirement.

3.03.33 **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 being part of DDCMIS/DCS/PLC) 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 values are laid to the application.

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

Individual moisture separator for O_2 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.

3.03.34 **Air Filter Regulator (AFR)**

Constant bleed type AFR with an accuracy of $\pm$ 1.0 % inlet pressure range of 5-10 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves with sintered phosphor bronze filter element; Filtering particles above five microns. IP 65 Weather and water proof enclosure. Material of accessories will be SS316. Body material of filter regulator shall be Die Cast Aluminum or 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.

3.03.35 **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 SS316. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" 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.

3.03.36 **Solenoid Valves**

Solenoid valves shall be provided as per NAMUR standard 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, Pneumatic 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 insulation class 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-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I) as applicable). Body material of solenoid valve shall be Brass or SS316 with epoxy paint as decided during engineering by owner. Material of wetted parts shall be SS316 only. Leakage class shall be class VI (Bubble tight).

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(f) All solenoid shall be with varister/RC circuit for EMI suppression, LED indication, surge

(g) Solenoid valve shall operate on 24 V DC, UPS 230 V AC or 220 V DC as per system requirements.

3.03.37 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 / Cm2.

3.03.40 **DEW POINT METER**

Type	:	2 Wire Loop Powered Dew point Transmitter
Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	AUTOMATIC CALIBRATION

- Can be Configured for Linear 4-20mA signal in °C & °F Dew point, ppm(v), ppb(v), g/m3
- Temperature Compensation
- Failure Diagnostics
- Long Term Stability
- Fast Response
- IP 66 / NEMA4X Protection
- Supplied with Calibration Certificate Traceable to National & International Humidity Standards
- Sensor protection with sintered filter
- Local LCD Display for Dew Point

3.03.41 **Junction Boxes**

Type of Enclosure	:	Flame proof/weather proof IP-65/Explosion Proof as per area classification. Design as per NEC-370 Article 18, 19 & 20.
Material	:	6 mm min. thick FRP with protective Coating 3 mm min. thickness Die cast aluminum for Flame proof/Explosion proof area.
Cable entry	:	Bottom or Side
Cable glands	:	Double compression type – Nickel plated brass with PVC hoods.
Mounting	:	Indoor/Outdoor
No. of terminals	:	As required with standardization with 20% spare of each size & type.
Terminals	:	Phoenix/Wago (screw less cage clamp type spring loaded)
Grounding	:	Two terminals for body and shield ground
Door	:	Hinged, lockable type.
Accessories	:	Suitable mounting clamps and other accessories shall be in scope of bidder. 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.

M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)
Gasket (Normal)- Neoprene/Polyurethene thickness 6.0 mm. Silicon for High Temperature area.

Colour : In General same as provided for control panels, and for special services, To be decided during detailed engineering & subject to owner's approval.

3.03.42 Cable Glands

Cables shall be terminated using double compression type cable glands. Cable glands shall conform to BS: 6121 & IP-67 and be of robust construction capable of clamping cable and cable Armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality.

3.03.43 Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V DC; 2 set of silver plated cadmium free with change over contacts rated for DC1 Breaking capacity of 0.5A 110 V DC/ 0.15 A 220 VDC and AC1 Capacity of 8/10 A 240 V AC. Capacity shall be as system requirements. Freewheeling diode across copper relay coil and self reset type status non-polarized LED indicator for the Coil (electronic) and a flag indicator for the Contacts (mechanical) shall be provided. Manual forcing/override facility is required. The insulation test voltage of 1.2/50 µs between the coil & contacts for relay shall not be less than 4 KV between adjacent contacts. The operating temperature of the Relay & Sockets shall be from –20 deg. C to 60 deg. C. The operating/release time of the relay shall not be more than 10/5 ms respectively.

The relay and DIN Rail sockets shall have the necessary approvals like UL/VDE and V0/V2 inflammability class in accordance with UL94", IEC60664/IEC60664A/DINVDE0110.

Facility to stimulate IPR manually shall be provided. The VA 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 and sockets shall have the plug in RC circuits/Varistors, required for EMI suppression.

3.03.44 RECORDERS (CHARTLESS)

Type : Micro-processor based, Digital TFT display type

No. of Channels : Six (6) points and Forty Eight (48) point).
The parameters shall be decided during detailed Engineering. Quantities of recorders for BTG packages shall be decided during detailed Engineering.
(Simultaneous parameter display preferred)

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LIST OF DOCUMENTS/DELIVERABLES

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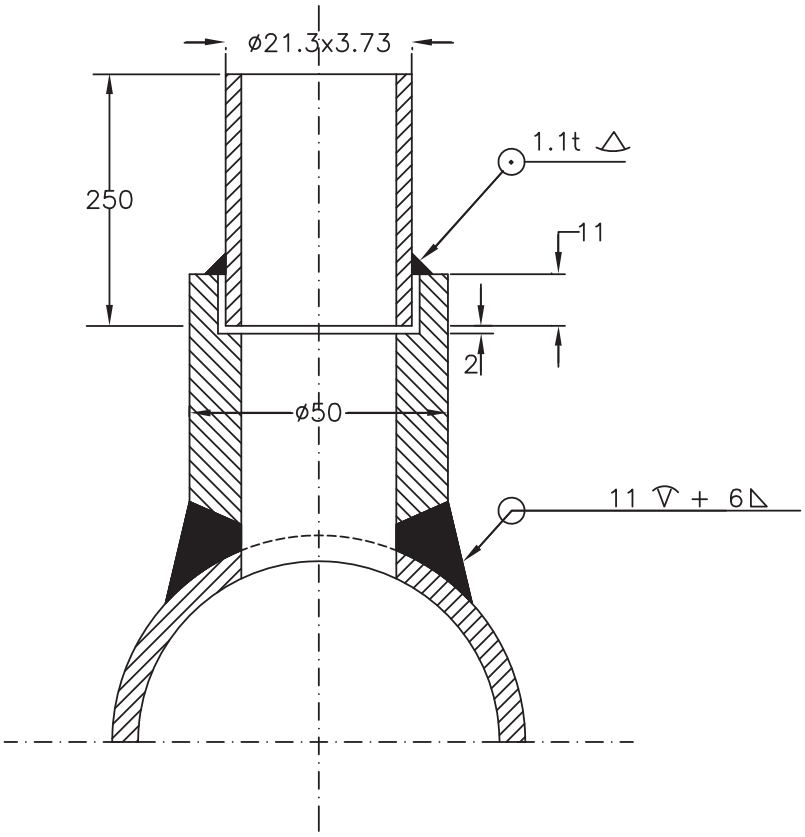
LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT			
Sl.No.	**DRAWING NO.**	**DRAWING/DOCUMENT TITLE**	**CATEGORY**
1	PE-V0-425-160-I901	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM	A
2	PE-V0-425-160-I902	CONTROL SCHEME/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DDCMIS)	A
3	PE-V0-425-160-I903	HMI PICTURES/PLANT SCHEMATICS	A
4	PE-V0-425-160-I904	INSTRUMENT SCHEDULE with set points	A
5	PE-V0-425-160-I905	I/O LIST (ANALOG & BINARY)	A
6	PE-V0-425-160-I906	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	A
7	PE-V0-425-160-I907	FIELD JB/LIE/LIR,DRIVES TERMINATIONS	A
8	PE-V0-425-160-I908	DATASHEETS FOR INSTRUMENTS, JBs, etc.	A
9	PE-V0-425-160-I909	QUALITY PLANS (INSTRUMENTS, VMS, etc.)	A
10	PE-V0-425-160-I910	INSTRUMENT HOOK-UP DRAWING	A
11	PE-V0-425-160-I911	THERMOWELL SIZING CALCULATION	A
12	PE-V0-425-160-I913	CABLE SCHEDULE & INTERCONNECTION	A
13	PE-V0-425-160-I914	ANNUNCIATION & SOE LIST	A

NOTES:
ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL,MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST,FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc.
SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.

`

INSTRUMENT STUB DETAILS



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
5. STUB LENGTH SHALL BE 64mm UPTO 200Nb, 45mm ABOVE 200Nb PIPE SIZE.
6. FOR PU COATED PIPE REFER SHEET No. 9

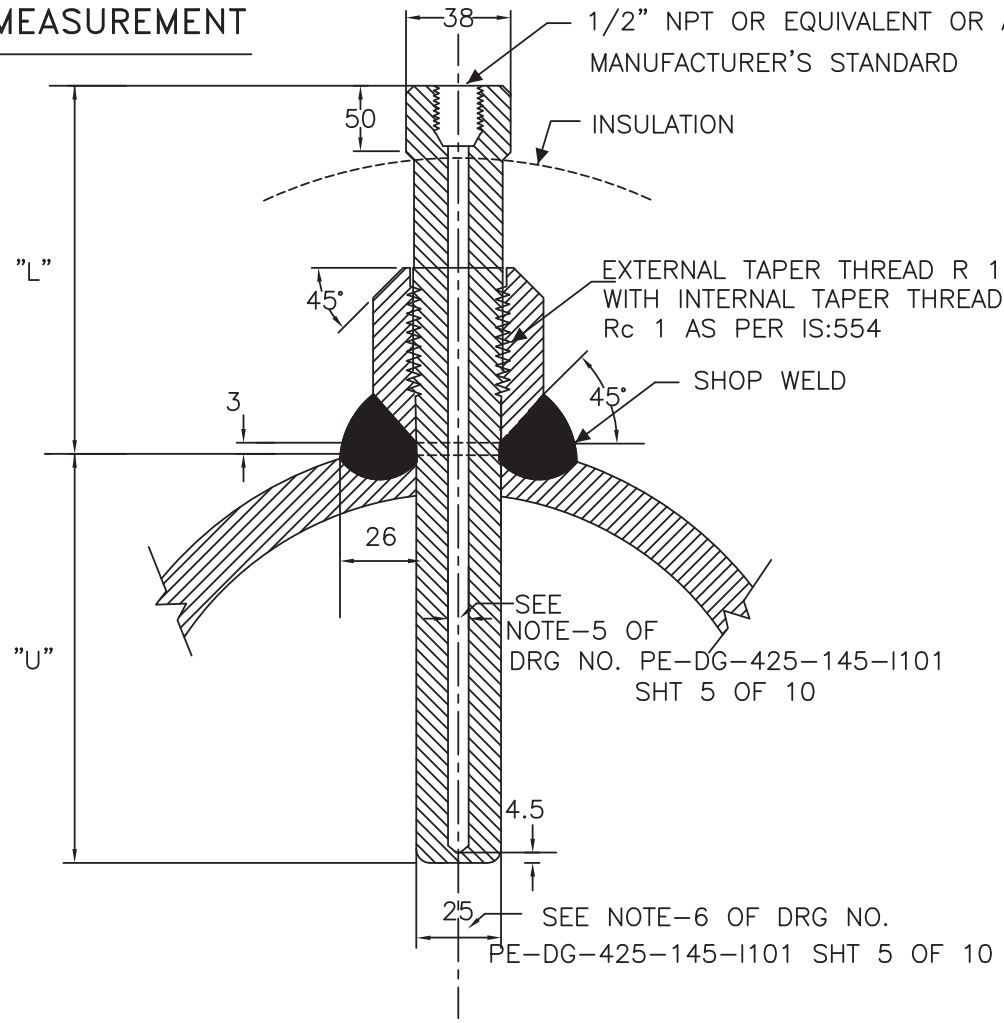
भेल BHEL

TITLE :
INSTRUMENT STUB DETAILS
FOR PRESSURE MEASUREMENT
(SYSTEM PRESS <60Kg/Cm2 & SYSTEM TEMP <425 DegC, CLASS 3000#)

DRG. NO.
PE-DG-425-145-I101
REV. 00

SH. 04 OF 10 SHS.

TEMP. MEASUREMENT

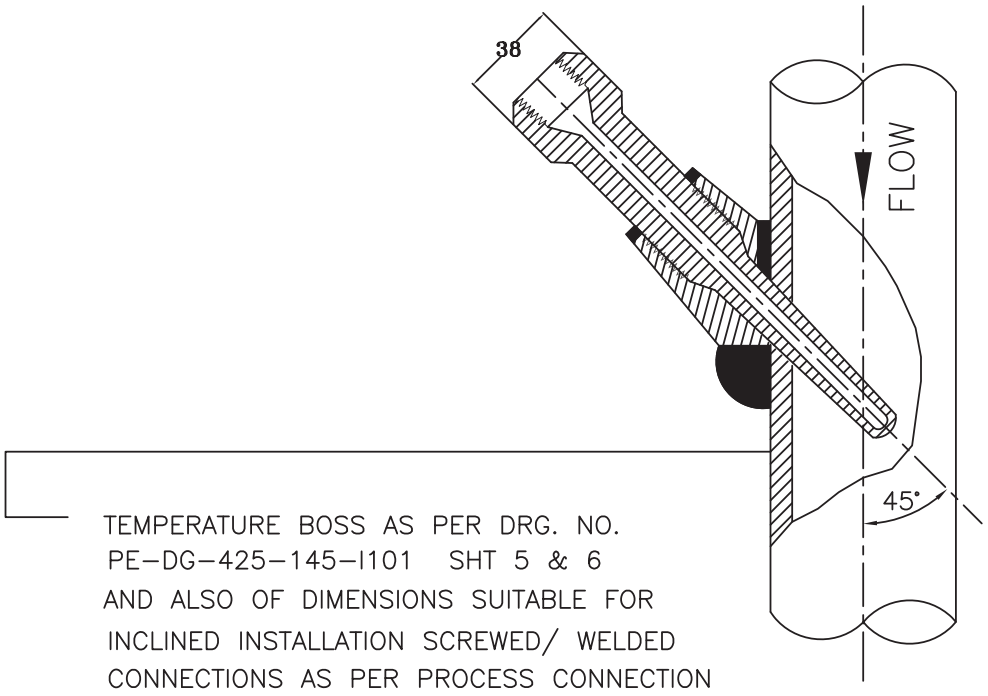


NOTES :–

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE PROCESS PRESS/ TEMP. BELOW 40 KG/CM2(g)/400°C.
2. SEE NOTES–2 TO 9 IN SHT. 5 OF 10 OF THIS DRG.

भेल BHEL	TITLE : INSTRUMENT STUB DETAILS (APPLICABLE FOR PIPE SIZE ABOVE 4") [PROCESS PRESS < 40 Kg/Cm2 (g),TEMP ≤ 400 ℃]	DRG. NO. PE–DG–425–145–I101 REV. 00 SH. 06 OF 10 SHS.

THERMOWELL SUITABLE FOR THE BOSS
AS PER DRG. NO.
PE–DG–425–145–I101 SHT 5 & 6



NOTES :–

1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION MAY BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (ATLEAST 3–4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDE OF INSTALLED THERMOWELL).

भेल BHEL	TITLE : INSTRUMENT STUB DETAILS THERMOWELL INSTALLATION	DRG. NO. PE–DG–425–145–I101 REV. 00 SH. 07 OF 10 SHS.

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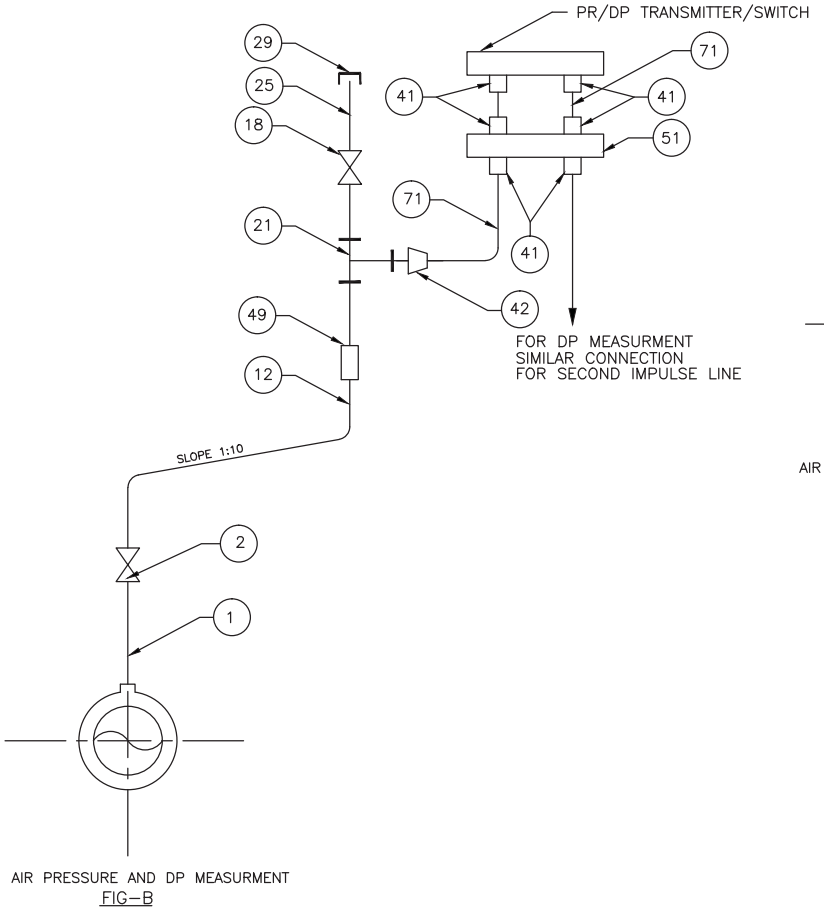
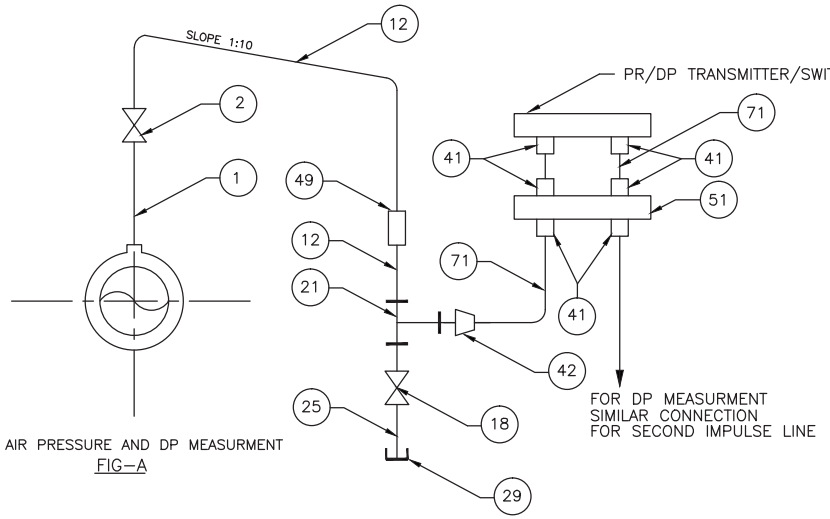
INSTRUMENT INSTALLATION DRAWING





TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
51	5/3/2–VALVE MANIFOLDS,SS–316	1	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	6	6
29	3/4"NPT(F) CS CAP	1	1
25	3/4"NPS,SCH–80 X 3/4"NPS(M)CS NIPPLE	1	1
21	3/4" EQUAL TEE,CS	1	1
18	3/4" SW,CS GLOBE VALVE	–	1
12	3/4" NPS. SCH–80 CARBON STEEL PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE – SW GLOBE VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

NOTE:–
QUANTITY IN COLUMN A&B TO BE DOUBLED
FOR DP TAPPING EXCEPT ITEM NO. 51

FOR BID PURPOSE ONLY

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.
6. FOR SEA/SALINE WATER APPLICATION MATERIAL OF ERECTION HARDWARE, IMPLUSE PIPE & TUBES SHALL BE SUPER DUPLEX SS ONLY.
7. ALL FITTINGS SHALL BE DOUBLE COMPRESSION TYPE.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15					SLN

REVISIONS — APPROVED

SR. No.	PARTY
	PRINT DISTRIBUTION

PROJECT	2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:–	DESEIN CONSULTING ENGINEERS NEW DELHI – INDIA

CAD/DRAWN	SANDEEP	20.07.15
DESIGNED	SKM/SN	17.07.15
CHECKED	SKM	22.07.15
APPROVED	SKM	19.08.15

TITLE: INST. DRAWING FOR PRESS. & DIFF. PRESS. TRANSMITTERS/SWITCH (AIR SERVICE)

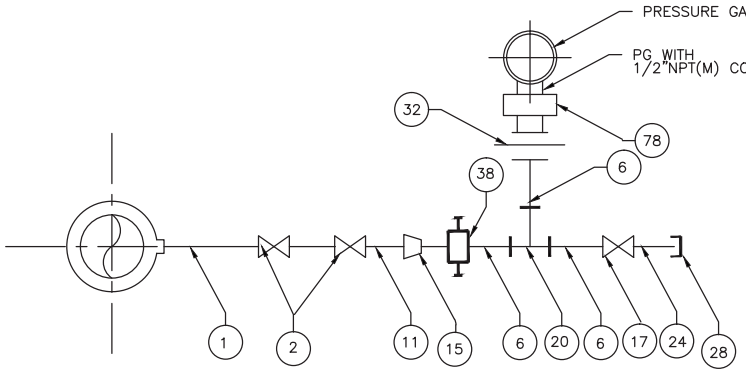
SCALE

JOB. No. D–0420

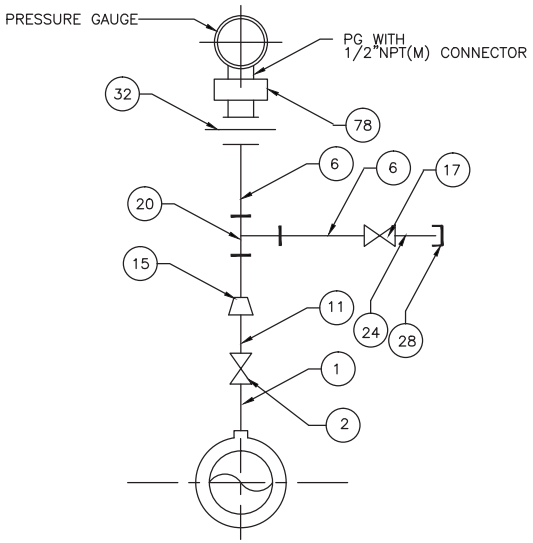
APPRD. FOR CONSTRUCTION:

DWG. No. 114–04–0103 Sheet No. 8 of 19

REV. 0



STEAM/LIQUID SERVICE
FIG–A



AIR SERVICE
FIG–B

TAG NO.	DESCRIPTION	QTY. A	QTY. B
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/PULSATION DAMPER	1	1
59	1/2"SW, STRAIGHT PIPE CONNECTOR, CS/AS	–	–
38	3 WAY 2 VALVE MANIFOLD FOR BTG SS316 3 WAY GAUGE VALVE I/2" NB SW FOR BOP SS316	1	–
37	6" COILED SYPHON SCH 80/160 1/2"NB CS/SS	–	–
32	1/2"NPS,3PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (F) CS CAP	1	1
24	1/2"NPS,SCH–80/160X1/2"NPT(M)CS/AS NIPPLE	1	1
20	1/2"SW EQUAL TEE, CS/AS	1	1
17	1/2" SW CS/AS GLOBE VALVE	1	1
15	1" TO 1/2" SOCKET WELDED REDUCER	1	1
11	1" NPS SCH–80/160 CS/AS NIPPLE	1	1
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE–SW GLOBE VALVE	2	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/ER
4. ABOVE DRAWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.
7. FOR SEA/SALINE WATER APPLICATION MATERIAL OF ERECTION HARDWARE, IMPLUSE PIPE & TUBES SHALL BE SUPER DUPLEX SS ONLY.
8. ALL FITTINGS SHALL BE DOUBLE COMPRESSION TYPE.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15				SLN	

REVISIONS — APPROVED

FOR BID PURPOSE ONLY

PROJECT	2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:–	DESEIN CONSULTING ENGINEERS NEW DELHI – INDIA

CAD/DRAWN	SANDEEP	20.07.15
DESIGNED	SKM/SN	17.07.15
CHECKED	SKM	22.07.15
APPROVED	SKM	19.08.15

TITLE: INST. DRAWING FOR LOCAL PRESSURE GAUGE

SCALE

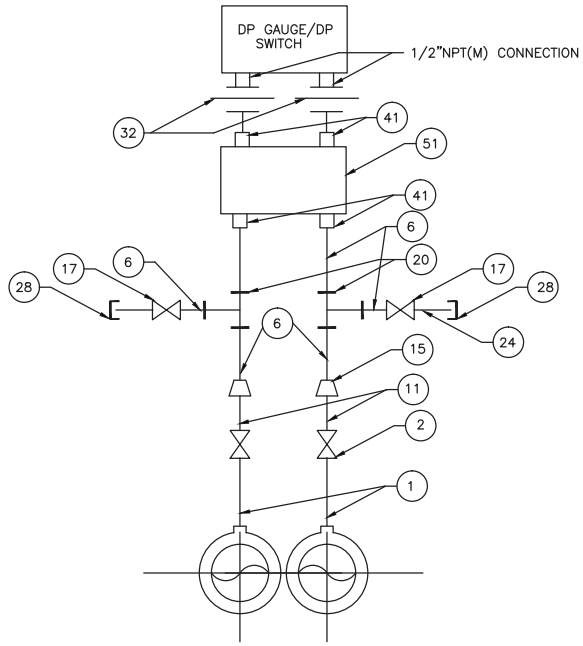
JOB. No. D–0420

DWG. No. 114–04–0106 Sheet No. 9 of 19

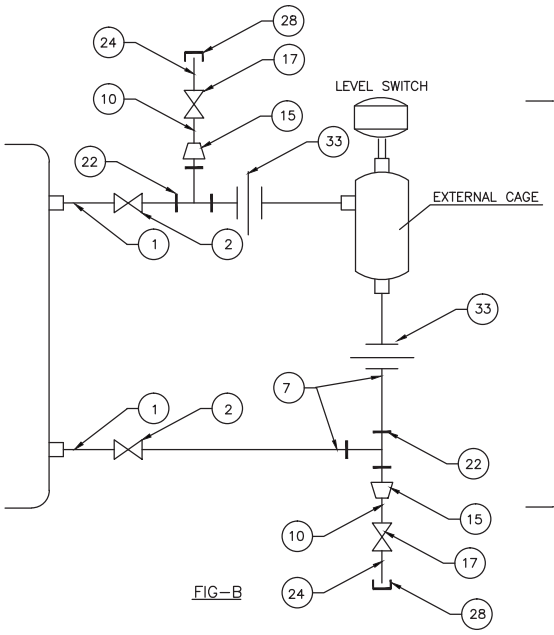
REV. 0

APPRD. FOR CONSTRUCTION:

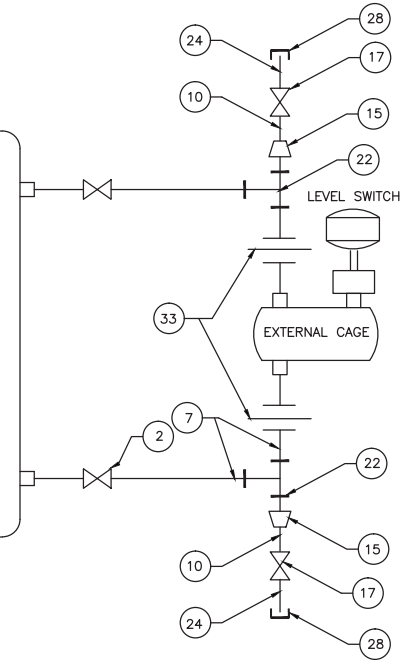
PRINT DISTRIBUTION — SR. No. | PARTY



FIG–A



FIG–B



FIG–C

78	1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER	1	–	–
51	5 VALVE MANIFOLDS, SS–316	–	–	–
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316	–	–	–
38	3 WAY GAUGE VALVE 1/2"NB SW	1	–	–
33	1" SW EQUAL PIPE UNION	–	2	2
32	1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION	1	–	–
28	1/2" NPT(F) CS. CAP	1	2	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE	1	2	2
22	1" SW EQUAL TEE CS/AS	–	1	2
20	1/2"SW EQUAL TEE CS/AS	1	–	–
17	1/2" SW,CS/AS, GLOBE VALVE	1	2	2
15	1" TO 1/2" SOCKET WELD REDUCER	1	2	2
11	1"NPS SCH 80/160 CS/AS NIPPLE	1	–	–
10	1/2"NPS,SCH 80/160 CA/AS NIPPLE	–	2	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE	AS REQD.		
7	1" NPS,SCH 80/160 CS/AS STEEL PIPE	AS REQD.		
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.		
TAG NO.	DESCRIPTION	A	B	C
		QTY.		

NOTE:–
WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

FOR BID PURPOSE ONLY

PROJECT	2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:–	DESEIN CONSULTING ENGINEERS NEW DELHI – INDIA
TITLE	INST. DRAWING FOR DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES
APPRD. FOR CONSTRUCTION:	

CAD/DRAWN	SANDEEP	20.07.15	SCALE	
DESIGNED	SKM/SN	17.07.15	JOB. No.	D–0420
CHECKED	SKM	22.07.15	DWG. No.	114–04–0108
APPROVED	SKM	19.08.15	REV.	0
			Sheet No. 11 of 19	

REFERENCE DRAWINGS.

NOTES

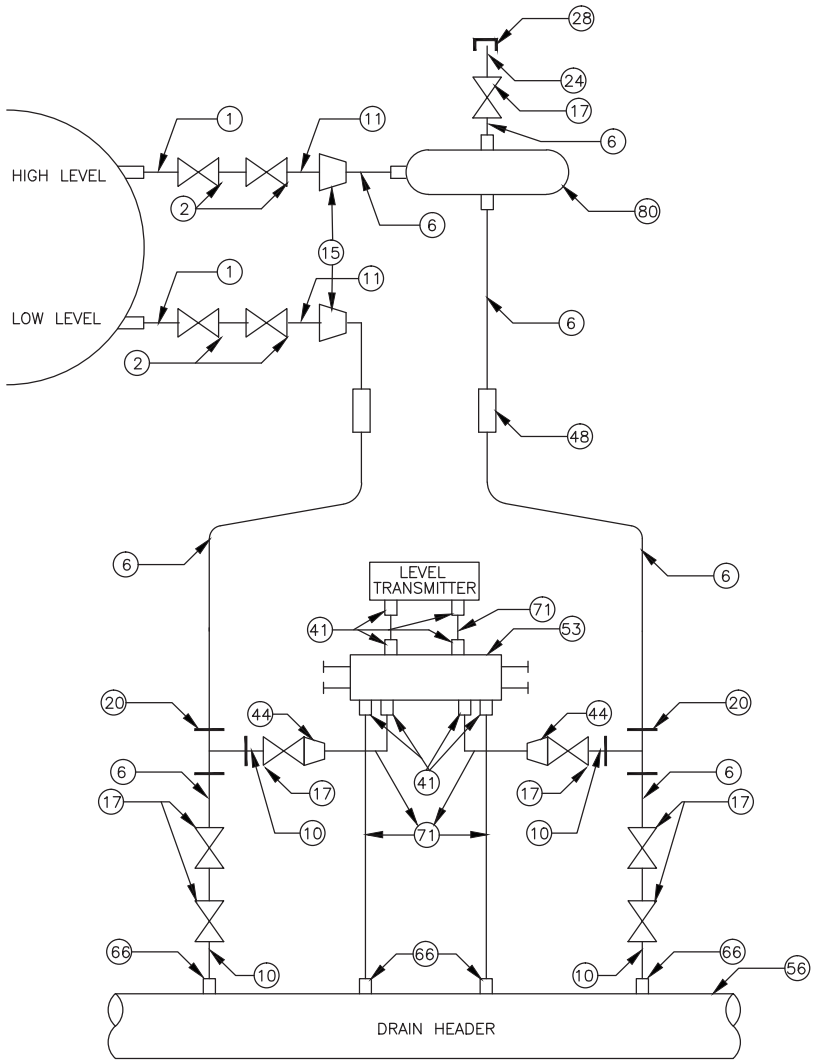
1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.
7. FOR SEA/SALINE WATER APPLICATION MATERIAL OF ERECTION HARDWARE, IMPLUSE PIPE & TUBES SHALL BE SUPER DUPLEX SS ONLY.
8. ALL FITTINGS SHALL BE DOUBLE COMPRESSION TYPE.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15				SLN	

REVISIONS — APPROVED

PRINT DISTRIBUTION — SR. No. | PARTY



TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

TAG NO.	DESCRIPTION	BOM
80	CONDENSATION CHAMBER	1
71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.
66	1/2" GI SOCKET / FUNNEL	4
56	2"NB GI DRAIN HEADER	AS REQD.
53	5-VALVE MANIFOLD, SS-316	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8
28	1/2" NPT (F) CS CAP	1
24	1/2" NPS SCH-80/160X1/2"NPT(M) CS/AS NIPPLE	1
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	7
15	1"TO 1/2" SOCKET WELD REDUCER	2
11	1" NPS SCH 80/160 CS/AS NIPPLE	2
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.
2	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.

NOTE:-
1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. DWG NO. 114-04-0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO

FOR BID PURPOSE ONLY

PROJECT	2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:-	DESEIN CONSULTING ENGINEERS NEW DELHI - INDIA
TITLE	INST. DRAWING FOR LEVEL TRANSMITTERS
APPRD. FOR CONSTRUCTION:	

CAD/DRAWN	SANDEEP	20.07.15	
DESIGNED	SKM/SN	17.07.15	
CHECKED	SKM	22.07.15	
APPROVED	SKM	19.08.15	
SCALE			
JOB. No.	D-0420		
DWG. No.	114-04-0110	REV.	0
Sheet No. 13 of 19			

REFERENCE DRAWINGS.

SR. No.	PARTY
PRINT DISTRIBUTION	

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LE/LR
4. ABOVE DRAWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER. ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.
7. FOR SEA/SALINE WATER APPLICATION MATERIAL OF ERECTION HARDWARE, IMPLUSE PIPE & TUBES SHALL BE SUPER DUPLEX SS ONLY.
8. ALL FITTINGS SHALL BE DOUBLE COMPRESSION TYPE.

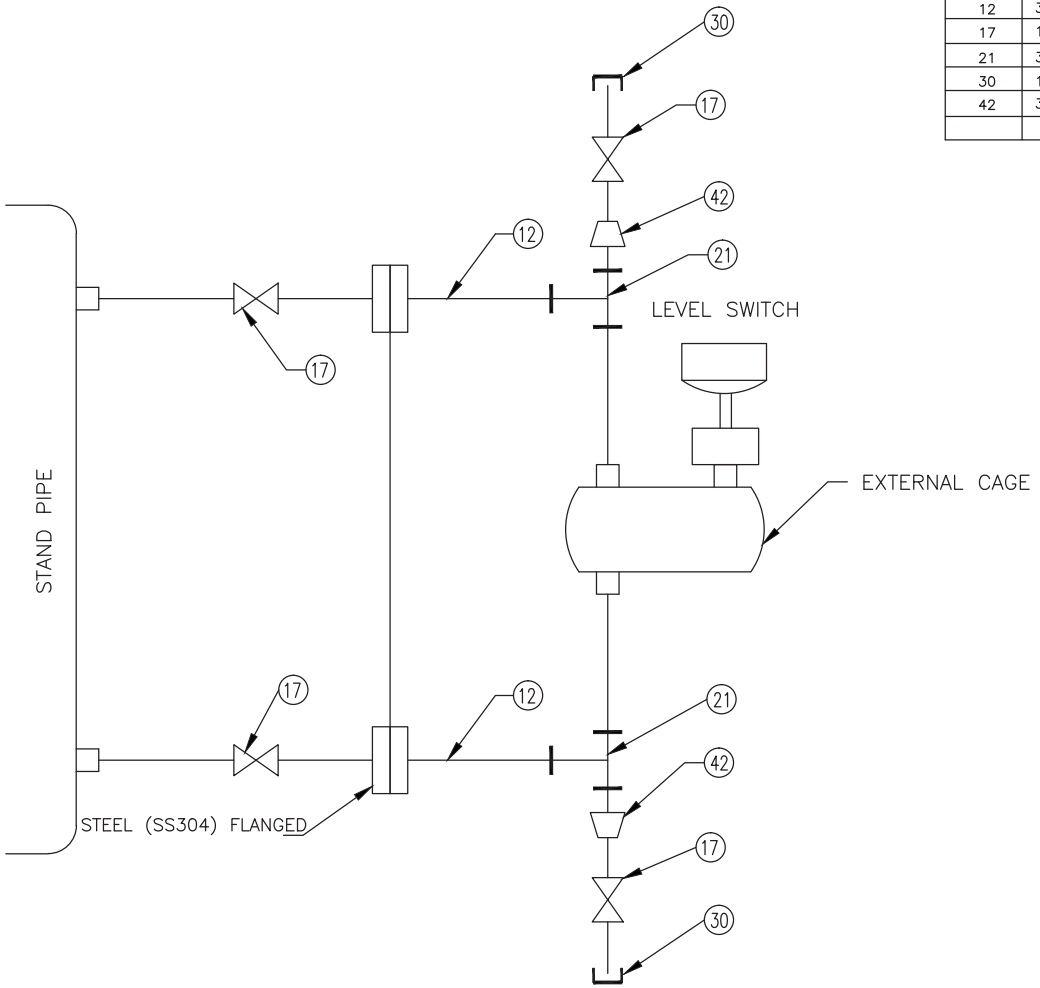
NOTICE

REVISIONS

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15					SLN

APPROVED

BILL OF MATERIAL		
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



FOR BID PURPOSE ONLY

PROJECT	2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:-	DESEIN CONSULTING ENGINEERS NEW DELHI - INDIA

CAD/DRAWN	SANDEEP	20.07.15
DESIGNED	SKM/SN	17.07.15
CHECKED	SKM	22.07.15
APPROVED	SKM	19.08.15

TITLE: INST. DRAWING FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION

SCALE:

JOB. No. D-0420

DWG. No. 114-04-0113 Sheet No. 17 of 19

REV. 0

APPRD. FOR CONSTRUCTION:

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.
5. FOR SEA/SALINE WATER APPLICATION MATERIAL OF ERECTION HARDWARE, IMPLUSE PIPE & TUBES SHALL BE SUPER DUPLEX SS ONLY.
6. ALL FITTINGS SHALL BE DOUBLE COMPRESSION TYPE.

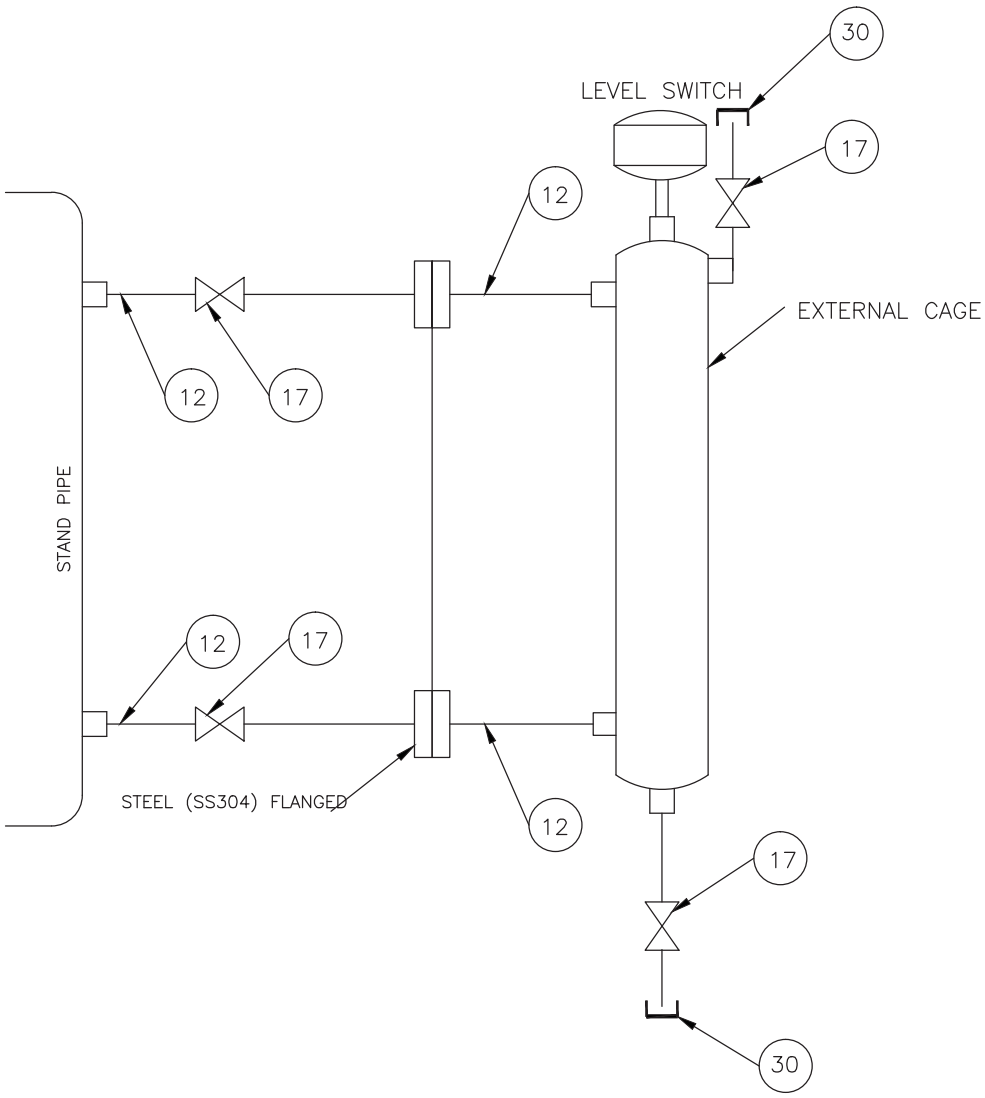
NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15				SLN	

REVISIONS — APPROVED

SR. No.	PARTY

PRINT DISTRIBUTION



BILL OF MATERIAL		
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2

FOR BID PURPOSE ONLY

PROJECT	2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:-	DESEIN CONSULTING ENGINEERS NEW DELHI - INDIA

CAD/DRAWN	SANDEEP	20.07.15
DESIGNED	SKM/SN	17.07.15
CHECKED	SKM	22.07.15
APPROVED	SKM	19.08.15

TITLE: INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

SCALE

JOB. No. D-0420

DWG. No. 114-04-0113 Sheet No. 18 of 19

REV. 0

APPRD. FOR CONSTRUCTION:

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.
5. FOR SEA/SALINE WATER APPLICATION MATERIAL OF ERECTION HARDWARE, IMPLUSE PIPE & TUBES SHALL BE SUPER DUPLEX SS ONLY.
6. ALL FITTINGS SHALL BE DOUBLE COMPRESSION TYPE.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15				SLN	

REVISIONS — APPROVED

PRINT DISTRIBUTION — SR. No. PARTY

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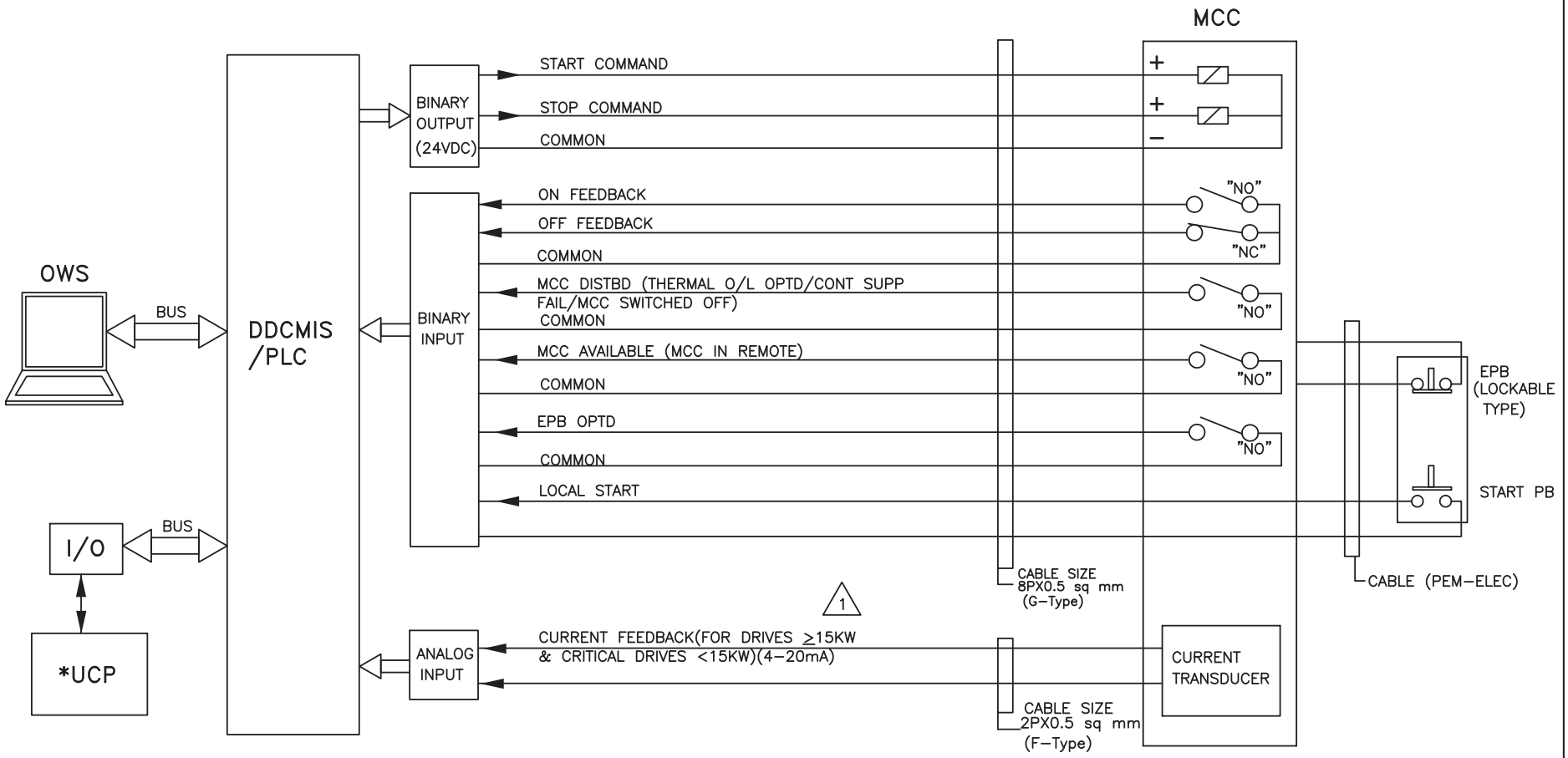
DRIVE CONTROL PHILOSOPHY

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



NOTE:

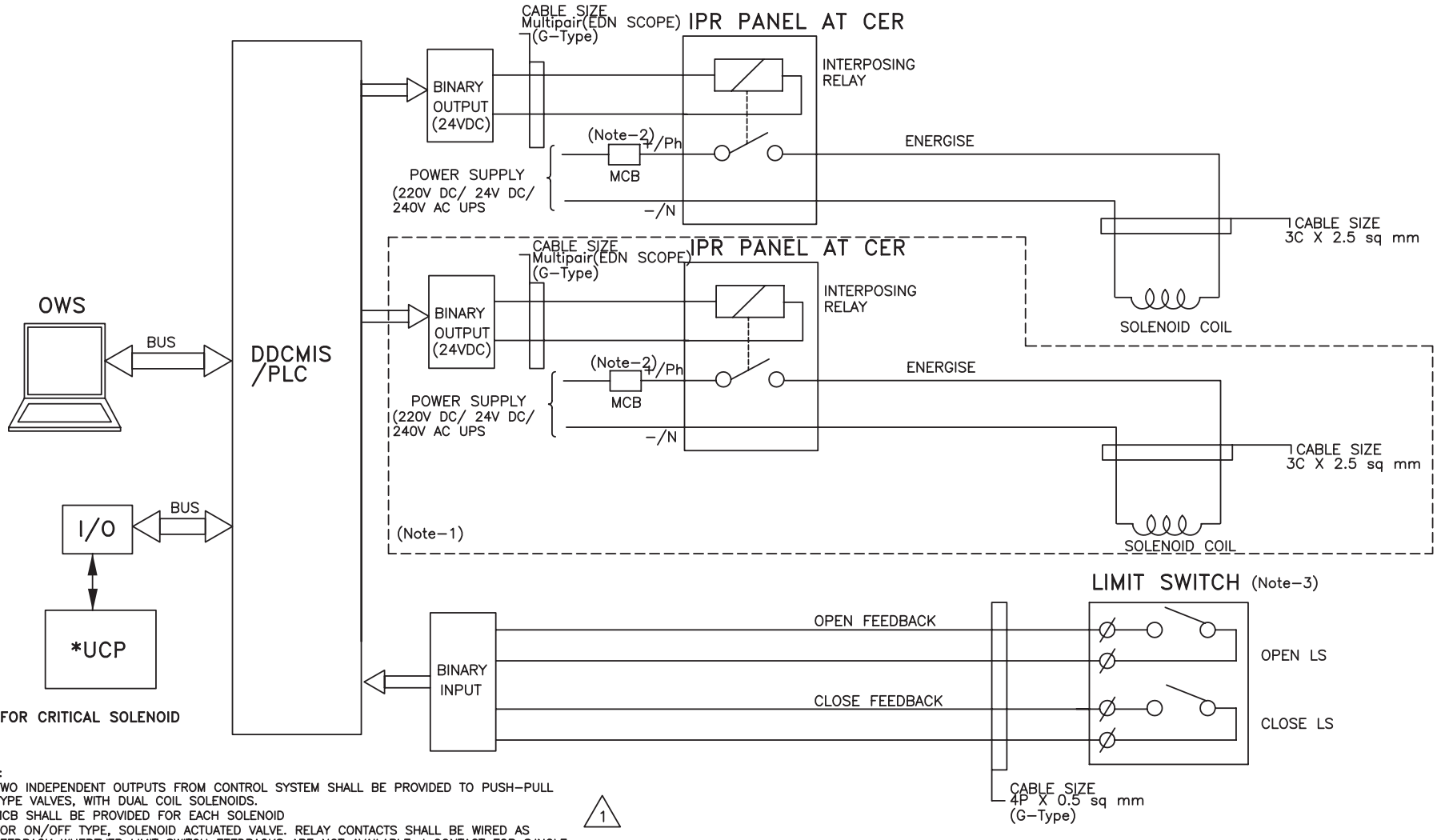
1) Redundancy of IO shall be as per specification requirement. △1

2) For LTUD, 4–20 mA Current Transducer shall be considered for all Lube Oil Pumps, Scanner Air Fans, Seal Air Fans. △2

* Wherever applicable

BHEL	PROJECT: 2X800 MW UPPUR STPP	DRG.NO.	PE–DM–425–145–I002
		DATE	20.04.2017
	TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO.	02
		SHT	8 OF 11

DCS INTERFACE FOR SOLENOID DRIVE
(220V DC/ 24V DC / 240V AC UPS)



NOTES:

1) TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.
2) MCB SHALL BE PROVIDED FOR EACH SOLENOID
3) FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE. 1 CONTACT FOR SINGLE COIL & 2 CONTACT FOR DUAL COIL (OPEN LIMIT SWITCH & CLOSED LIMIT SWITCH.
4) BHEL WILL TAKE CARE OF DE-ENERGISE TO TRIP PHILOSOPHY FOR FAIL SAFE CONTROL SYSTEM (WHEREVER REQUIRED)
5) REDUNDANCY OF IO SHALL BE AS PER SPECIFICATION REQUIREMENT.
6) FEEDBACK OF SOLENOID DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT TO THE DCS.

1

2

BHEL	PROJECT: 2X800 MW UPPUR STPP	DRG.NO.	PE-DM-425-145-I002
		DATE	20.04.2017
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	02
		SHT	9 OF 11

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KKS TAGGING PHILOSOPHY

TYPICAL INSTRUMENT SCHEDULE WITH KKS TAG

UNIT - I & II BAY 1 & 2

(MILL - A TO MILL -……) SYSTEM 101 - …… & SYSTEM 201 - ……..

S. NO	KKS NO.	INST. TYPE	SERVICE
1	ZZEUAXXCL201	RF TYPE LSD (HIGH-HIGH)	LEVEL SENSING TO CONFIRM GRID CHOKING IN PYRITE HOPPER (LSH)
2	ZZEUAXXCL202	RF TYPE LSD (HIGH)	LEVEL SENSING TO START THE CYCLE IN PYRITE HOPPER (LS)
3	ZZEUAXXCT201	TEMPERATURE SWITCH	TEMPERATURE SENSING OF PYRITE HOPPER (TS1)
4	ZZEUAXXCP511	PRESSURE GAUGE	INDICATION BACK PRESSURE IN VESSEL (PG1)
5	ZZEUAXXCP512	PRESSURE GAUGE	INDICATION OF INLET PRESSURE TO SYSTEM (PG2)
6	ZZEUAXXCP202	PRESSURE SWITCH	SENSING INLET PRESSURE TO SYSTEM (PS2)
7	ZZEUAXXCP201	PRESSURE SWITCH	SENSING BACK PRESSURE WHILE CONVEYING (PS1)

COMMON ITEMS FOR ALL MILLS OF THE UNIT - I BAY 1 & 2

S. NO	KKS NO.	INST. TYPE	SERVICE
1	01EUA15CP514	PRESSURE GAUGE	INDICATION OF AIR RECEIVER - 1 PRESSURE OF BAY-1 (PG4)
2	01EUA16CP515	PRESSURE GAUGE	INDICATION OF AIR RECEIVER - 2 PRESSURE OF BAY-2 (PG5)
3	01EUA19CP516	PRESSURE GAUGE	INDICATION OF INSTRUMENT AIR HEADER PRESSURE BAY-1 (PG6)
4	01EUA20CP517	PRESSURE GAUGE	INDICATION OF SERVICE WATER HEADER PRESSURE BAY - 1 (PG7)
5	01EUA21CP516	PRESSURE GAUGE	INDICATION OF INSTRUMENT AIR HEADER PRESSURE BAY-2 (PG8)
6	01EUA22CP517	PRESSURE GAUGE	INDICATION OF SERVICE WATER HEADER PRESSURE BAY - 2 (PG9)
7	01EUA19CP203	PRESSURE SWITCH	SENSING OF INSTRUMENT AIR HEADER PRESSURE BAY-1 (PS3)
8	01EUA20CP204	PRESSURE SWITCH	SENSING OF SERVICE WATER HEADER PRESSURE BAY - 1 (PS4)
9	01EUA21CP203	PRESSURE SWITCH	SENSING OF INSTRUMENT AIR HEADER PRESSURE BAY-2 (PS5)
10	01EUA22CP204	PRESSURE SWITCH	SENSING OF SERVICE WATER HEADER PRESSURE BAY - 2 (PS6)
11	01EUA15CP205	PRESSURE SWITCH	SENSING OF SERVICE AIR RECEIVER - 1 PRESSURE BAY-1 (PS7)
12	01EUA16CP206	PRESSURE SWITCH	SENSING OF SERVICE AIR RECEIVER - 2 PRESSURE BAY-2 (PS8)
13	01EUA15CT511	TEMPERATURE GAUGE	INDICATION OF SERVICE AIR RECEIVER-1 BAY-1 TEMPERATURE (TG1)
14	01EUA16CT512	TEMPERATURE GAUGE	INDICATION OF SERVICE AIR RECEIVER-2 BAY-2 TEMPERATURE (TG2)
15	01EUA17CL203	RF TYPE LEVEL SENSING DEVICE	LEVEL SENSING FOR SILO - 1 FILL (LSDSH1)
16	01EUA17CP201	DIFFERENTIAL PRESSURE SWITCH	DIFFERENTIAL PRESSURE SENSING OF BAG FILTER SILO - 1 (DPS1)
17	01EUA18CL204	CONDUCTIVE TYPE LEVEL SWITCH	WATER LEVEL SENSING FOR HI-HI, HI & L LEVEL BAY-1 (LSSP1)
18	01EUA18CL205	CONDUCTIVE TYPE LEVEL SWITCH	WATER LEVEL SENSING FOR HI-HI, HI & L LEVEL BAY-2 (LSSP2)

COMMON ITEMS FOR ALL MILLS OF THE UNIT - II BAY 1 & 2

S. NO	KKS NO.	INST. TYPE	SERVICE
1	02EUA15CP514	PRESSURE GAUGE	INDICATION OF AIR RECEIVER - 1 PRESSURE OF BAY-1 (PG10)
2	02EUA16CP515	PRESSURE GAUGE	INDICATION OF AIR RECEIVER - 2 PRESSURE OF BAY-2 (PG11)
3	02EUA19CP516	PRESSURE GAUGE	INDICATION OF INSTRUMENT AIR HEADER PRESSURE BAY-1 (PG12)
4	02EUA20CP517	PRESSURE GAUGE	INDICATION OF SERVICE WATER HEADER PRESSURE BAY - 1 (PG13)
5	02EUA21CP516	PRESSURE GAUGE	INDICATION OF INSTRUMENT AIR HEADER PRESSURE BAY-2 (PG14)
6	02EUA22CP517	PRESSURE GAUGE	INDICATION OF SERVICE WATER HEADER PRESSURE BAY - 2 (PG15)
7	02EUA19CP203	PRESSURE SWITCH	SENSING OF INSTRUMENT AIR HEADER PRESSURE BAY-1 (PS9)
8	02EUA20CP204	PRESSURE SWITCH	SENSING OF SERVICE WATER HEADER PRESSURE BAY - 1 (PS10)
9	02EUA21CP203	PRESSURE SWITCH	SENSING OF INSTRUMENT AIR HEADER PRESSURE BAY-2 (PS11)
10	02EUA22CP204	PRESSURE SWITCH	SENSING OF SERVICE WATER HEADER PRESSURE BAY - 2 (PS12)
11	02EUA15CP205	PRESSURE SWITCH	SENSING OF SERVICE AIR RECEIVER - 1 PRESSURE BAY-1 (PS13)

12	02EUA16CP206	PRESSURE SWITCH	SENSING OF SERVICE AIR RECEIVER - 2 PRESSURE BAY-2 (PS14)
13	02EUA15CT511	TEMPERATURE GAUGE	INDICATION OF SERVICE AIR RECEIVER-1 BAY-1 TEMPERATURE (TG3)
14	02EUA16CT512	TEMPERATURE GAUGE	INDICATION OF SERVICE AIR RECEIVER-2 BAY-2 TEMPERATURE (TG4)
15	02EUA17CL203	RF TYPE LEVEL SENSING DEVICE	LEVEL SENSING FOR SILO - 2 FILL (LSDSH2)
16	02EUA17CP201	DIFFERENTIAL PRESSURE SWITCH	DIFFERENTIAL PRESSURE SENSING OF BAG FILTER SILO - 2 (DPS2)
17	02EUA18CL204	CONDUCTIVE TYPE LEVEL SWITCH	WATER LEVEL SENSING FOR HI-HI, HI & L LEVEL BAY-1 (LSSP3)
18	02EUA18CL205	CONDUCTIVE TYPE LEVEL SWITCH	WATER LEVEL SENSING FOR HI-HI, HI & L LEVEL BAY-2 (LSSP4)
COMMON ITEMS FOR ALL UNITS			
S. NO	**KKS NO.**	**INST. TYPE**	**SERVICE**
1	01EUA23CP513	PRESSURE GAUGE	INDICATION OF COMPRESSOR COMMON AIR HEADER PRESSURE (PG3)
2	00EUA24CP517	PRESSURE GAUGE	INDICATION OF COMMON AIR RECEIVER - 7 PRESSURE (PG22)
3	00EUA24CP207	PRESSURE SWITCH	SENSING OF COMMON SERVICE AIR RECEIVER - 7 PRESSURE (PS21)
4	00EUA24CT513	TEMPERATURE GAUGE	INDICATION OF COMMON SERVICE AIR RECEIVER-7 TEMPERATURE (TG7)
ZZ STANDS FOR THE UNIT NO. (01 FOR UNIT-1, 02 FOR UNIT-2)			
XX STANDS FOR THE SYSTEM NO. OF THE RESPECTIVE UNIT (01,02 , 03 , …….)			

NOTES:-

1.IF THE NUMBER OF EQUIPMENT/INSTRUMENTS CHANGES, THE KKS FOR THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

2.FOR INSTRUMENTS KKS 6th AND 7th PLACE VALUE OF KKS CODE SHALL BE CHANGED FOR CORRESPONDING EQUIPMENT AS FOLLOWS:-

1.FOR PRESSURE -CP

2.FOR TEMPERATURE/GT/AT/TEMP SENSOR-CT

3.FOR LEVEL-CL

4.FOR FLOW-CF

5.R.H.SENSOR-CM

FOR INSTRUMENTS 8th,9th AND 10th PLACE VALUE OF KKS CODE SHALL BE CHANGED FOR CORRESPONDING EQUIPMENT AS FOLLOWS:-

1.FOR PRESSURE/TEMPERATURE/LEVEL TRANSMITTER-011

2.FOR PRESSURE/TEMPERATURE/LEVEL GAUGE-511

3.FOR PRESSURE/TEMPERATURE/LEVEL SWITCH-111

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DATA SHEETS FOR MOTORISED VALVE ACTUATOR

FORM NO. PEM-6666-0

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE: 05.10.16
		SHEET 1 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

GENERAL*	* PROJECT	2 x 800 MW Uppur Thermal Power Project	
	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 -20 to70 DEG C AND RELATIVE HUMIDITY OF 0-95%IN HOT HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST	
	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,DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/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 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 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) ■ SIEMENES GRAY RAL 7030	
	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 +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ■ 110 V	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE: 05.10.16
		SHEET 2 OF 4

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	
	@ 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(Reversing type) ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐……	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN-STOP-CLOSE PB(running open/close LED) THREE POSITION SELECTOR SWITCH	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■REQUIRED ☐ NOT REQUIRED	
	LOCAL-OFF- REMOTE S/S(THREE POSITION SELECTOR SWITCH)	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIPO/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD.)	
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	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 250V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	■2 Nos. | 2 nos(adj) | 1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 250V AC AND 0.5A 220V DC	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE: 05.10.16
		SHEET 3 OF 4

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 for regulating/inching duty only.	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) contactless inductive type	
	SUPPLY	■ 24V DC ☐ ……	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	240V AC 1 ph 50Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@■ IP 68 @☐ NEMA6	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	■ REQUIRED ☐ NOT REQUIRED☐ ■ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	During detailed engineering	
	@ SPACE HEATER CABLE GLAND		
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	1 no suitable for 8P X 0.5 sq mm Additional 1 no suitable for 2P X 0.5 sq mm(inching duty only)	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE: 05.10.16
		SHEET 4 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

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 INTERNATION 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. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.

4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.

5. 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.

6. 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%.

7. 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.

8. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.

9. POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL

10. WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.

11. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE AND RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.

12. THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE.

13. ALL SIX (6) LIMIT SWITCHES SHALL BE CHANGEOVER TYPE AND ADJUSTABLE BESIDES HAVING THE SNAP FACILITY.

14. THE INTEGRAL STARTER WHICH SHALL HAVE SOPHISTICATED ELECTRONIC CONTROLS WITH FIELD PROGRAMMING FEATURE. IT SHALL BE DESIGNED FOR REMOTE CONTROL FROM DCS/RESPECTIVE CONTROL SYSTEM. REQUIRED INTERPOSING RELAYS FOR RECEIVING OPEN/CLOSE/STOP COMMAND FROM DCS/RESPECTIVE CONTROL SYSTEM SHALL BE PROVIDED. POTENTIAL FREE CONTACTS AND TRANSDUCERS SHALL BE PROVIDED TO PROVIDE STATUS INDICATION AT REMOTE DCS/RESPECTIVE CONTROL SYSTEM.

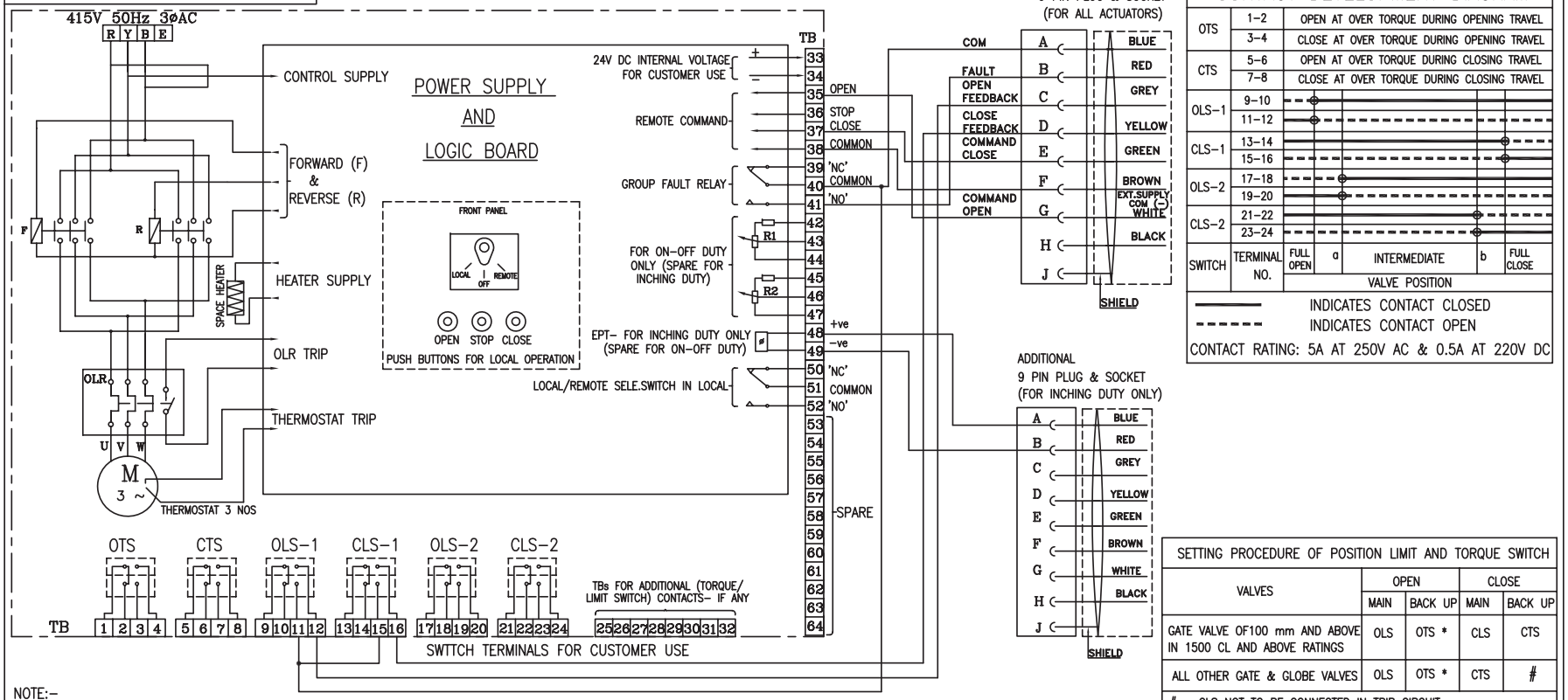
15. THE REMOTE COMMAND SIGNAL (OPEN-STOP-CLOSE) FROM DCS/RESPECTIVE CONTROL SYSTEM/CONTROL PANEL SHALL BE ISOLATED FROM CONTROL ELECTRONICS THROUGH OPTO-ISOLATOR.

16. THE FOLLOWING INDIVIDUAL STATUS ANNUNCIATION LED'S (COLOUR-GREEN) SHALL BE PROVIDED LOCALLY (INTEGRAL TO ACTUATOR) TO ANNUNCIATE THE FOLLOWING FOR EASY LOCAL MONITORING.
    ACTUATOR IN LOCAL MODE
    ACTUATOR IN REMOTE MODE
    ACTUATOR RUNNING IN OPEN DIRECTION
    ACTUATOR RUNNING IN CLOSE DIRECTION
    ACTUATOR IN INCHING MODE.
    ACTUATOR IN SELF-RETAINING MODE
    LIMIT SWITCH OPEN TRIP
    LIMIT SWITCH CLOSE TRIP
    CONTROL VOLTAGE AVAILABILITY

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

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24283



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	

SWITCH / TERMINAL NO. — FULL OPEN | a | INTERMEDIATE | b | FULL CLOSE — VALVE POSITION

INDICATES CONTACT CLOSED
INDICATES CONTACT OPEN

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

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

\# - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT
* - BYPASS OTS FOR INITIAL 5% OF TRAVEL(FOR GATE VALVES ONLY)

NOTE:-

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
2. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
5. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
6. EPT - ELECTRONIC POSITION TRAMSMITTER (CONTACTLESS TYPE, FOR INCHING DUTY)
7. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M - MOTOR 3ø 415V 50 Hz AC SUPPLY
10. TORQUE SWITCH BYPASS WITH LIMITSWITCH BOTH ON OPEN & CLOSE DIRECTION TO BE DONE INTERNALLY.

REV	DATE	ALTERED
		CHD & APPD

TYPE OF PRODUCT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
2 X800 MW UPPUR TPP
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

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

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

TITLE: WIRING DIAGRAM (TERMINAL PLAN)
FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24283

REV: 0

Size A3

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QUALITY ASSURANCE FOR INSTRUMENTS & LCP AND TYPE TEST REQUIREMENTS

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL/TAG NO.						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS CHECK	100%		P	W	V	
3	ACCURACY	100%		P	W	V	
4	SWITCHING DIFFERENTIAL	100%		P	W	V	
5	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
6	MATERIAL TC FOR BULB, CAPILLARY, ARMOUR	ONE / LOT		P	V	V	
7	HV / IR	RANDOM		P	W	V	
8	DEGREE OF PROTECTION	TYPE TEST		P	V	V	
9	THERMOWELLS						
	DIMENSIONS,PROCESS CONN	100%		P	W	V	
	MATERIAL TC	ONE / LOT		P	V	V	
	HYD TEST	100%		P	W	V	
	IBR CERTIFICATE, IF APPLICABLE			P	V	V	
10	REPEATABILITY	100%		P	V	V	
11	HYSTERISIS	100%		P	V	V	
12	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. Manufacturer to carry out routine test for 100%

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	SEE NOTE-5		P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE,WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. IBR certificates shall be provided wherever required.
6. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

CHECK LIST FOR TEMPERATURE ELEMENT

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL No./TAG No.						
	PROCESS CONNECTION						
2	STABILITY			P	W	V	
3	INSULATION RESISTANCE			P	W	V	
4	ENCLOSURE CLASS			P	W	V	
5	RESPONSE TIME			P	W	V	
7	ACCURACY			P	W	V	
8	HYDROSTATIC TEST			P	W	V	
9	ELECTRICAL CHARACTERISTIC OF SENSOR (CONTINUTY OF T/C WIRES & INSULATION RESISTANCE OF RTD LEADS w.r.t. BODY			P	W	V	
10	TEMP CURVES / CHARTS			P	V	V	
11	AMBIENT TEMP. EFFECT CHECK			P	W	V	
12	HV TEST			P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. IBR certificate to be provided, if applicable

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST			P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. IBR certificate to be provided if called for in specn.
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

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TYPE TEST REQUIREMENTS

Note-1: Test to be witnessed by Owner.

NOTES:

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the FAT has been accepted by Owner.

2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

13.02.04.21 **Calibration of Instruments**

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

i TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1.	Pressure Gauges
	Calibration Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Switches
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity : ± 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.

	Calibration / Material test / Bore concentricity test / Insulation test (≤ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: ± 5% of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test (≥ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : ± 5% of wall thickness.
9.	Thermowells
	Material test / Bore concentricity : ± 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10.	Level Guages
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
12.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	Control valves/Pneumatic block valve/Pressure regulating valve – Refer chapter 11.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable & Instrumentation Cables and Fiber Optical Cables

	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable. (Also refer chapter 9 for further details). For Deatils of type and acceptance tests for Instrumentation Cables refer chapter 9. For Deatils of tests for Fiber Optical Cables refer chapter 9.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers and other analysers:
	Calibration test, Accuracy test
27.	Sample cooler :
	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
30.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
31.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	Temperature Transmitter
	Calibration test / Accuracy test /Ambient temperature error test
35	Pneumatic & Hydraculic Block Valves

	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	Pressure Regulating Valve (Pneumatic & Hydraculic type)
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	Wiring Termination & Accessories
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.
	Type test:Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
39	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
40.	Transmitter/Switch Enclosures & Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
	Notes:

	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.

13.02.05 TYPE TESTING

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, TYPE TEST REQUIREMENT FOR C&I SYSTEM and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments. type test may be conducted as per manufacturer standards or if required by relevant standards.

A. Out of these test listed , the bidder /subvendor/manufacturer is required to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

B. For the rest, submission of type test , results, and certificates shall be acceptable provided following points

i. The same has been carried within last five years from the date of bid opening.

ii. The same have been carried out by the bidder/ subvendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).

iii. There has been no change in the components from the offered equipments and tested equipments.

iv. The test has been carried out as per the latest standards along with amendemends as on the date of bid opening.

v. The test should have been either carried out at any Govt. approved laboratory and test witnessed by a client of Government Department / Government

C. In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

13.02.05.1 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer.

The schedule of conduction of type test/submission of reports shall be submitted and finalized during pre award discussion.

13.02.05.2 For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

13.02.05.3 SPECIAL REQUIREMENTS FOR SOLID STATE EQUIPEMNTS /SYSTEMS

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS, PLC etc shall be as indicated below:

i. Surge Withstand Capability (SWC) for solid state equipments/equipments

All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant . All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc including power supply , data highway, data links shall be provided with protection that meets the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Complete details of th features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates ,etc shall be submitted along with the proposal. As an alternative to the above , suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.

ii. The dry heat test as per IEC-68-2-2 or equivalent
iii. Damp heat test as per IEC 68-2-3 or equivalent
iv. Vibration test as per IEC 68-2-6 or equivalent
v. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
vi. Radio frequency immunity test as per EN 61000-4-6 or equivalent
vii. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no v, vi, vii above are applicable for electronic cards only as defined under item no. (i) above

13.02.05.4 TYPE TEST REQUIREMENTS FOR C&I SYSTEMS

S.No.	Item	Test requirement	Standard	Test to be specifically conducted	Owner's Approval required on Test Certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes

2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447/IEC 60770	No	Yes
6	E/P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. V, Chapter 9)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	**DDCMIS/DCS**				
	CLCS system	Model Test	Approved procedure	No	No
	BMS & MFT	Safety requirement	VDE 0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves of each type (Pneumatic & Hydraculic)	CV test	ISA 75.02	No	YES
15	PLCs	As per Standard	IEC 1131	No	YES
16	LIE/LIR	Degree of protection test	IS 13947	YES	YES
17	Flue gas O2 analyser, other Flue gas Analysers	Degree of protection test	IS 13947	No	YES
18	Flow nozzles	calibration	ASME PTC BS	YES	YES

	& Orifice plates		1042		

Note:
Type test are to be conducted only for the items, which are being supplied as part of this package.

A. For batteries with electric power supply system of main plant C&I, the bidder shall submit for owner's approval the reports of all the type tests as per IS-10918 carried out within last 5 years from the date of bid opening and the test should have been either conducted at an independent laboratory or should have been witnessed by a owner/client. The complete type test report shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.

For batteries with electric power system of auxiliary plants, type test reports for batteries shall be as per standard –practice of manufacturer.

13.02.06 Testing at Site [Prior to commercial operation]

a. All equipment shall be checked thoroughly in respect of the following:

i. Visual and mechanical testing

ii. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.

iii. Checking of loop configuration & OS displays; correct functioning of all keyboards; correct change-over of redundant devices; proper functioning of printer, sample printing of all types of log reports, shutdown reports and MIS reports; shutdown system.

iv. Loading of user's programme and checking out of results.

Repeating any or all such tests (as necessary) as performed at works.

b. Modulating Control Loop Test

Loop test performed after calibration of all instruments and leak test of signal lines to check the functional performance of all elements of loop. Control loop testing shall be generally by simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. The field/receiver pressure switches shall be simulated for abnormality by disconnecting the wires of terminals and checking the function of all associated systems. Performance of individual loops may be accepted for an overall accuracy of $\pm$0.5%. After the loop test is complete, the bidder shall connect back any terminations and connections removed for loop check.

c. Protection, Interlocking Sequence Control Loop Checking

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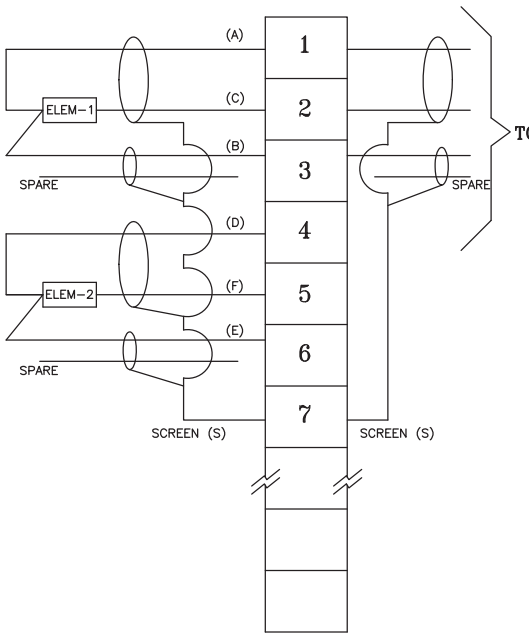
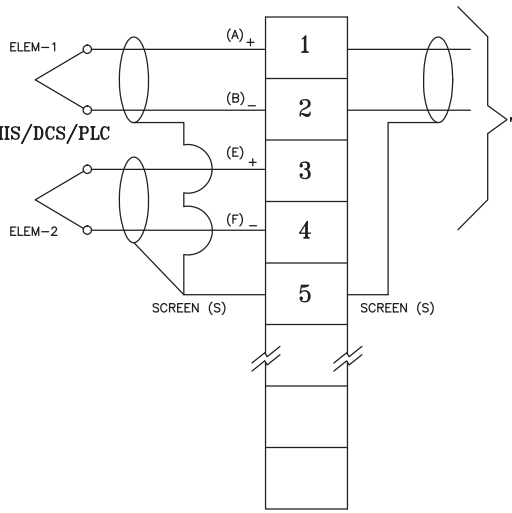
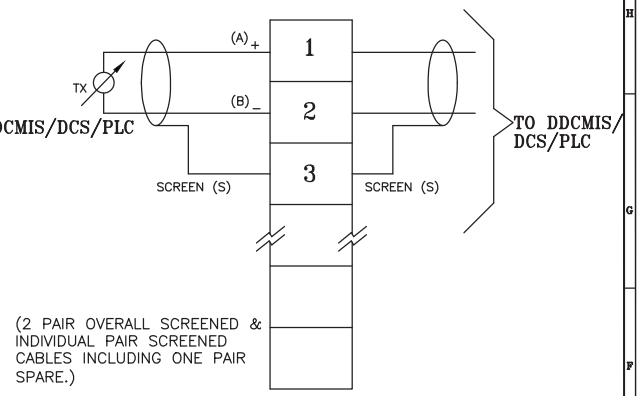
INSTRUMENTATION CABLE, CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX RTD



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX THERMOCOUPLE



TYPICAL CONNECTION DIAGRAM
FOR TRANSMITTER

NOTE :–

1. SPLITTING OF CABLE MAY OCCUR WHEN TERMINALS REQD FOR AN ELEMENT ARE LOCATED ON SEPARATE STRIPS. HENCE, NO. OF TBS ON A TERMINAL STRIP SHALL BE ADDJUSTED TO PREVENT SPLITTING. 20% SPARE TB SHALL BE PROVIDED.
2. SCREENS SHALL BE EARTHED AT DDCMIS/DCS/PLC END ONLY. NO EARTHING OF SCREEN TO BE DONE AT JB/INSTRUMENT END
3. OVERALL SCREEN OF OUTGOING AND ASSOCIATED INCOMING CABLE TO BE CONNECTED TOGETHER ON A SPARE TERMINAL AND THEN CONNECTED TO EARTH AT DDCMIS/DCS/PLC END.
4. FOR SWITCH, BOTH CONTACTS SHALL BE CONNECTED TO JBs WITH 2 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES.

FOR BID PURPOSE ONLY

PROJECT	**2x800MW SUPERCRITICAL COAL BASED UPPUR THERMAL POWER PROJECT**
OWNER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED
OWNER CONSULTANT:-	DESEIN CONSULTING ENGINEERS NEW DELHI – INDIA

CAD/DRAWN	SANDEEP	20.07.15	
DESIGNED	SKM/SN	17.07.15	
CHECKED	SKM	22.07.15	
APPROVED	SKM	19.08.15	

TITLE: TYPICAL WIRING ARRANGEMENT IN JB

SCALE:

JOB. No. D–0420

DWG. No. 114–13–0103 REV. 0

Sheet No. 1 of 1

APPRD. FOR CONSTRUCTION:

SR. No.	PARTY
PRINT DISTRIBUTION	

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	0	FOR BID PURPOSE ONLY	19.08.15				SLN	

REVISIONS APPROVED

8.04.04.4 INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted group Junction Baxes (JBs) at strategic locations is done and consequently cable with higher numbers of pairs are extensively used between field & Marshalling panels. The details of termination to be followed are mentioned in the given table below:-

Application	**Type of Termination**		
FROM (A)	**TO (B)**	**END A**	**END B**
Valves/Dampers Drives (Integral Junction Box)	Marshalling/ Marshalling-cum Termination Cubicle/ Local group JB	Plug in connector	Post mount cage clamp type
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction Box of LIE/LIR	Plug in connector	Cage clamp (Rail mount type)
RTD heads	Local Junction Box	Plug in Connector	Cage clamp (Rail mount type)
Thermocouple	Local Junction Box	Plug in Connector	Cage clamp (Rail mount type)
Other Field mounted Instruments	Local JB/ Group JB	Plug in Connector	Cage clamp (Rail mount type)
RTD heads	Temperature transmitter	Plug in Connector	Screwed Cage Clamp Type
Thermocouple	Temperature Transmitter	Plug in Connector	Screwed Cage Clamp Type
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JBs.	Group JB	Cage clamp (Rail mount type)	Cage clamp (Rail mount type)
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JB/ MCC/SWGR	Marshalling/ Marshalling – cum Termination Cubicles.	Cage clamp (Rail mount type)	Cage clamp (Post mounted type)
Marshalling cubicle/Termination System Cabinets	Electronic system Cabinet	Cage clamp (Post mounted type)	Plug-in connector/other system as per Mfr's standard
Marshalling/ Termination System Cabinets	UCD mounted equipments	Cage clamp (Post	Plug in Connector/ Cage

		mounted type)	clamp Type (rail mounted)
DDCMIS/PLC cabinets	OWS, Printer etc.	Plug in connector	Plug in Connector

Notes

1. For Analog signals, individual pair shieldiing & overall shielding & for Binary signals, only overall shielding of instrumentation cables (> 2 pair) shall be provided.

2. Signal and 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. All screwed connections shall be provided with double compression type Nickel-plated brass cable glands.

4. All spare contacts/terminals on relays, control switches, limit switches or similar devices, process switches, duplex RTDs & Duplex T/Cs shall be wired to accessible terminal blocks/JBs for future connections. All wiring leaving a junction box or enclosure shall leave from terminal blocks and not from other devices in the enclosure. Two (2) pair (individual & overall shielded) cables shall be provided for terminating the thermocouples, transmitters & switches i.e Analog & Binary signals to local JBs. Similarly four (4) pair (individual & overall shielded) cables shall be provided for terminating the Duplex (3 wire) RTD to local JBs.

   Four (4) pair (individual & overall shielded) cables shall be provided for terminating the switches to local JBs, where both NC & NO contacts are used in DDCMIS/DCS/PLC.

5. Separate mutipaired cable shall be provided for each drive between MCC/SWGR and DDCMIS/PLC.

6. 10% spare pairs or min 1 pair cable (which ever is more) shall be provided with all type of cables.

8.04.04.5 Conduits

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

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

The Bidder shall install conduits according to the general routing as approved by owner and shall coordinate conduit locations with other works.

All grounding bushings within all enclosures shall be wired together and connected internally to the enclosure grounding lug or groubnding bus with 8 AWG bare copper conductors. Conduit runs to individually mounted equipment shall be groubnded to the Owner's cable tray grounding conductor with 12 AWG bare copper conductor. All grounding bushing, clamps, and connectors shall be subject to approval of the owner.

All rigid conduit fiitings shall conform to the requirements of IS: 2667, 1976. Galvanised steel fittings shall be used with steel conduits. All flexible conduit fittings shall be liquid tight, galvanised steel. The end fittings shall be compatible with flexible conduit supplied.

All individually mounted equipment and devices shall be connected to the supply conduit, using not more than one metre of flexible conduit adjacent to the equipment or device. Flexible conduit shall be installed in all conduit runs, which are supported by both building steel and structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by the turbine generator foundation and where conduit supported by building steel or foundation becomes supported by steam generator framing.

Special areas, such as control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main Duilding framing to the control room framing.

Conduit supports shall be furnished and installed in accordance with these specifications. Support material shall comply with the following requirements.

i) Hanger rods shall be 12 mm diameter galvanized threaded steel rods.

ii) Single conduit supports shall be one-hole cast metal straps and clamp backs unless other types are acceptable to the Employer. Multiple conduit bank supports shall be constructed of special galvanized support channels with associated conduit clips.

Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specification and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Hazardous area fittings and conduits sealing shall conform with NEC requirements for the area classification.

Bidder shall provide double locknuts on all conduit termination not provided with threaded hubs and couplings. Water tight conduit unions and rain tight conduit hubs shall

be utilised for all the application which shall be exposed to weather. Moisture pockets shall be eliminated from conduits.

Conduits shall be securely fastened to all boxes and cabinets.

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MANDATORY SPARE LIST

MANDATORY SPARES FOR MILL REJECT HANDLING SYSTEM

C&I Mandatory Spares (QUANTITY PER UNIT)

S. No.	ITEM	QUANTITY
1	**Indicators, Recorders, Electrical Metering and Skid**	
a.	For skid mounted instruments	10% of total numberof Instruments, valves, C&I equipment, C&I items etc. for each Type and number for each model and type, whichever is more.
b.	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10 % of Installed of each type/ Model or a minimum of one Number for each model and type, whichever is more.
2	**Temperature Elements and Thermowells**	
a.	Thermocouples and RTD elements	10% spare for each type and length of element furnished with thermocouple and RTD assemblies, or a minimum of one number of each type & length, whichever is more. The element assembly shall be suitable for direct replacement in the corresponding thermowell.
b.	Thermowells	10% for each type of temperature sensors or a minimum of one for each type, whichever is more.
3	Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Process Transmitters, Level & Flow Transmitter for each type, Rotameters, Sight Flow indicators, Temperature, Pressure, Flow & Level Switch, safety & Protection switches, Gauges, Process meters, Junction Boxes, Position Transmitters/switches, Analysers, or any other instrument etc.	I. 10% of total number of each item offered for each model and type for the project or a minimum of one number,whichever is more. II. 10% of Electronic card/ PCB assembly and power supply card/ module for each type, model & rating of Transmitter, analyzers & Flow maters.
4	Level Gauges	a) 10% or 2 nos. whichever is more of each type of illuminators with holder and reflector.
		b) 20% or 5 nos. whichever is more of each type of bulb.
		c) 10% or 2 nos. whichever is more of each type of bicolor rollers.
		d) 10% or 2 nos. whichever is more of each type of glass along with pair of gaskets (cushion gaskets) included & wet gaskets).
		e) 10% or 2 nos. whichever is more of each type of gaskets for gauge cocks/valve bonnet/ packing.
		f) 10% or 2 nos. whichever is more of each type scale.
5	Solenoid valve	20 percent or min 10 no. of each type & model for total qty. (whichever is more)
6	PANEL ILLUMINATION	100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.
7	FUSES & MCB	50 % spare fuses shall be provided with each panel, these are in additional to mentoned in point no. 8(e).
8	**Erection hardware**	
a.	Instrument valves, manifold, fittings, impulse pipe, impulse tubes, drains pipes,	Ten (10) percent of each type, rating, model number & Size installed
b.	Manifold	Ten (10) percent of each type & Size installed
c.	Fittings	Ten (10) percent of each type & Size installed
d.	MCB, and Power sockets used in LIE/LIR.	Ten (10) percent of each type.
e.	Fuses used in LIE/LIR.	Fifty (50) percent of each type.
9	Mandatory spares not covered above Sensor/ instrument, analyzers/ special instruments/ Electronic card, instrumentation/ mechanical fittings etc.	10% or 1 no. (whichever is more) of each type.

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SUB VENDOR LIST

SUB VENDOR LIST (AS ON 28-09-2017)

SL. NO.	Package Name	Supplier Name	Supplier Communication Address
1	Cold Junction Compensation Box (CJCB)	CREATIVE INSTRUMENTS & CONTROLS	NO-17/1 , 1ST FLOOR , 11TH CROSS 1ST K BLOCK , RAJAJINAGAR, BANGALORE-560010 Phone- Pincode : Email : crinstruments@gmail.com
2	INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com
		Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com
		Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com
		HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com
		AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
		PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
		FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com
		VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
		Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
		PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,
3	INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
		Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
		PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
		AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
4	INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
		Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
		AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
		PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
5	JUNCTION BOX	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com
		SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra.industriesblr@gmail.com
		FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com
		K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net
		AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, imajmera@yahoo.com
6	LEVEL GAUGE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com
		TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com
		SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
		H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
		BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net

7	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
		PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
		Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.- MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
		H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
		FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
		GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com
		Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
8	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com
		Barksdale GmbH, Germany	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de
		SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, No.127 & 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : marketing@switzerinstrument.com
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		INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mktg@indfos.com
		GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com
		SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
		INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com
		Kaustubha Udyog,	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune, Phone- 020-24393577, Pincode : Email : pressure@vsnl.com,
9	TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com
		Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com
		Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com
		PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in
		TECHNO INSTRUMENTS	Abhijit Gohel/Mr. Amit Pandya Plot No. 1145/1, Uma Convertor Lane, Santej,Ta. Kalol, Gandhinagar Phone- 9909925223 Pincode : 382721 Email : amit@techno-instruments.com
		Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.- MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
		TM TECNOMATIC SPA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com
		TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
		GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
		GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
		Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
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		FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
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		GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,

10	TEMPERATURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
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		A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
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11	TEMPERATURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com
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		SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
		INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com
		SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, No.127 & 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : marketing@switzerinstrument.com
12	TRANSMITTERS	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
		ABB LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com
		Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
		Moore Industries International Inc.	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com
		PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,
		TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
		Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,
		YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,
		SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in
		SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com
		EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com
		SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in
		NIVO CONTROLS PVT. LTD.	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com
		Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com

NOTE:

1. The above sub-vendor list is tentative & reference only. However Sub-Vendor List is subject to BHEL/ end user approval without any commercial/ delivery implication.

2. New Sub-Vendor if proposed by Vendor during contract stage shall subject to BHEL/ end user approval without any commercial/ delivery implication.

SECTION – II

STANDARD TECHNICAL SPECIFICATION

SUB-SECTION IIA – Standard Technical Requirement (Mechanical)

Mill Discharge Spout and Pyrite Hopper

- Each coal mill has a discharge spout with a pneumatic cylinder operated knife gate valve for discharging rejects into a pyrite hopper of adequate capacity. This hopper shall serve to store the mill rejects between each operating cycle of dense phase system. Minimum effective storage capacity shall be 2-3 times the effective (batch capacity) of the conveying vessel.

- Each pyrite hopper shall be provided with a knife gate valve of approved design at the bottom, adequately sized manhole/inspection door, sizing gird and emergency chute with Knife gate valve and reject quenching arrangement (water spray) shall be provided. Any platform/ structural support (as per IS 2062 Gr A/B) required to maintain the above equipment before transporter vessel's inlet valve. Necessary explosion vent (rupture disc with MOC Aluminium) of proven design shall be provided in each pyrite hopper.

- Each emergency chute shall be provided with a knife gate valve to transfer mill rejects from pyrite hopper to ground or to Owner's trolley. Necessary access and platform shall be provided. Limit switches shall be provided to indicate the valve position on control panel.

- Each pyrite hopper shall be provided with two level switches – one to start the operating sequence and the other to indicate the hopper above grid chocked condition.

- Open & Close Limit switches shall be provided in all KGVs and these limit switches shall be interlocked with MRS control system. Solenoid box cum local control panel shall be provided. Same shall house system start stop, vessel pressure indication, probe over ride, purge button so that system can be locally optd. It shall be possible to operate individual vessel from local pneumatic panel for few cycles in emergency.

- Following control modes shall be provided

- Remote mode: System shall be controlled through MRS control System.

- Local Mode:

a) Energized mode: Manual override shall be selected from MRS control System. System logic shall be executed in MRS control system itself.
b) De-energized mode: MRS control system shall be delinked and system (individual stack up assembly) shall be operated manually.

- The sizing grid shall be provided inside the pyrite hopper to prevent oversized mill rejects, tramp iron etc. from entering the conveying vessel. The arrangement for collecting bigger pieces of coal rejects from the grid includes, among others, Knife Gate Valve, chute work etc. Bigger pieces of coal rejects shall roll down from the grid and through KGVs, chute work etc. Bigger pieces of coal rejects shall roll down from the grid and can be removed through the over sized seized reject removal gate (to be provided preferably at the bottom of inspection door) be discharged to Owners trolley. The arrangement shall be finalized during detail engineering. The grid shall be made of minimum 10 mm dia.

CONVEYING VESSEL

1.0 GENERAL

This specification covers the PURCHASER'S general requirement of design, materials, constructional features, manufacture, inspection and testing at VENDOR''S works and/or his sub vendor's works of Conveying Vessel and accessories specified hereinafter.

2.0 CODES AND STANDARDS

2.1 The design, material, construction, manufacture, inspection and performance of the Transporter and accessories, shall comply with all statutory regulations and safety codes currently applicable in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable Indian/British/USA/DIN Standards.

2.2 The material of construction and other works of the Transporter and accessories shall in general conform to the following standards/codes but will be subjected to any modification and requirement as specified in Section C of Technical Speciation.

i) Transporter Vessel – Mild Steel to IS 2062 (Gr. A min); Construction as per IS-2825 / BS5500/ASME SEC-VIII, Div-1
ii) Material Handling Valve – As indicated in Sec-C of the specification
iii) Flange – MS as per ANSI B 16.5

2.3 Where the above standards are in conflict with the stipulations of this specification, this specification supersedes them. In case of any further conflict in this matter, the decision of the Engineer will be final and binding.

3.0 DESIGN REQUIREMENTS

3.1 The dense phase pneumatic conveying system shall be designed for low velocity for conveying of materials as indicated in Section C.

3.2 The system shall consist of dome shaped vessels made of Carbon Steel complete with pneumatically operated dome/metering valves capable of closing through a solid head of material to make a pressure tight seal.

3.3 The bottom of vessel shall have transition bend and a control air supply system to the side of the conveying vessel.

3.4 Airtight seal system shall be provided between the transporter and the feeding point.

3.5 Transporter shall be equipped with **air strainer** to prevent pipe scale /dirt from causing pressure regulator malfunctioning.

3.6 Automatic drain filter and oil fog lubricator set shall be fitted into the air line to dome valve/metering valve for use with pneumatic controls.

3.7 Any air line stop valve fitted in the air supply line of transporter shall be of ball type to avoid any restriction to air flow, when open.

4.0 CONSTRUCTIONAL FEATURES

4.1 The transporter vessel shall be fabricated from mild steel plate to the design of vendor. The vessel shall be of welded structure and shall be provided with necessary supporting structure. The vessel shall be airtight/leak proof in fully assembled condition. Conveying vessel shall be designed and tested as per IS

2825 vessel. Temperature of mill reject coming into the conveying vessel shall be considered as 200 °C. Conveying vessel shall be designed for a pressure 10% above the maximum pressure encountered in the vessel. The conveying vessel shall be constructed with tested quality mild steel plates. They shall withstand the abrasive & hot condition of the mill rejects and operating air pressure. The conveying vessel shall be supported independently on steel columns. The vessel shall have suitably located and adequately numbered air connections for supply of compressed air for conveying mill rejects through pipes to overhead bin.

4.2 Dome/Metering valve shall be of manufacturer's standard construction and will be easily openable and closeable type. All joints will be flanged with asbestos free or silicon rubber gaskets suitable for 200 °C.

4.3 All bends will be of long radius cast bends (R = 5D). Conveying pipes will be of mild steel heavy duty type.

5.0 TESTING AND INSPECTION

5.1 The purchaser shall have free access to those parts of manufacturer's works which are concerned with the fabrication of the steel work and shall be afforded with all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of this specification

5.2 Should any structure or part of a structure be found not to comply with any of the provision of this specification, it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for inspection/test except in cases where the purchaser or his authorized representative considers the defect as rectifiable defects which may appear during fabrication shall be made with the consent of and according to the procedure laid down by the purchaser, the purchaser may, at his discretion, check the test results obtained at the manufacturer's works by independent tests at the Government test house or elsewhere, and should not be found to be unsatisfactory shall be rejected. The costs of such tests shall be borne by the contractor.

5.3 Scope of inspection shall include but not limited to the following:

i) Material used in the fabrication shall be with manufacturer's test certificate with proper correlation for physical properties and chemical analysis. In the absence of correlation actual tests shall be done.

ii) Welders shall be qualified as per ASME Standard. Only qualified welders shall be employed for the fabrication purpose.

iii) Electrodes shall be of makes approved by BHEL.

iv) All fillet welds, root run and trial run of butt welds shall be subjected to visual dye penetrating test with no linear indication. Acceptable norm for dye-penetrating test shall be as per Appendix-8 of ASME SEC. VII Div. 1.

v) Special tests like NDT as per relevant code will be carried out for fabrication items.

vi) Chemical analysis and hardness tests of linear plates shall be carried out.

vii) Dimension shall be maintained as per approved drawings.

MILL REJECT BUNKER AND ACCESSORIES

1.0 GENERAL

1.1 This specification covers the PURCHASER'S general requirement of design, manufacture, fabrication, assembly, inspection, testing and delivery to site or mill reject bunker and accessories specified.

2.0 CODES AND STANDARDS

2.1 The design, material, construction, manufacture, inspection, testing and performance of the mill reject bunker shall comply with all statutory regulations and all safety codes currently applicable in the locality where the equipment will be installed.

2.2 The material of construction and other works of the mill reject bunker shall in general conform to the following standards /codes but will be subject to any modification and requirements as specified in the specification.

a)	Structural steel	:	IS-2062 Gr A (min)
b)	Rolled Steel Beams, Channels and Angle Sections	:	IS-808
c)	Scheme of Symbols for Welding	:	IS-813
d)	Covered Electrodes for Metal Arc Welding of Structural Steel	:	IS-814
e)	Code of practice for use of Metal Arc Welding for general Construction in Mild Steel	:	IS-816
f)	Code of practice for inspection of Welds	:	IS-822
g)	Code of practice for use of structural steel in general building construction	:	IS-800
h)	Dimension for steel plate, sheet and Strip for structural and general Engineering purposes	:	IS-1730
i)	Recommendation for metal arc welding	:	IS-9575

2.3 Where the above standards are in conflict with the stipulations of this specification, the specification supercedes them. In case of any further conflict in this matter, the decision of the ENGINEER shall be final binding.

3.0 DESIGN REQUIREMENT

3.1 The coal mill reject bunker shall be fabricated of mild steel plate with adequate stiffeners welded on. The bunker shall be supported on the concrete foundation provided by the purchaser. Foundation bolts, gratings etc. shall be provided by the bidder.

3.2 The reject bunker shall be complete with twin sector discharge gate, stainless steel liners, flanged connections, platforms, gratings/chequered plates, access staircase, hand railings etc. The equipment shall be designed and equipped for outdoor operation, complete with all accessories.

4.0 CONSTRUCTIONAL FEATURES

4.1 The bunker shall be of welded structure and shall be provided with necessary supporting structure. Flanged opening shall be provided at the bottom of the bunker for attaching the twin sector gate. The inclined part of the bunker shall be designed with a valley angle of not less than 60 deg. To the horizontal. The design of the bunker shall be such that the problem of formation of arch is eliminated. The inside surface shall be provided with liner MOC as specified elsewhere in the specification. Explosion diaphragm/Pressure relief valve shall be provided to release air from the bunker in case pressure inside the bunker exceeds 1 .0 kg/cm^2(g)

4.2 Vendor shall furnish all steel work required for support and access for operation and maintenance. This shall include platforms, grating/chequered plates, stairways, hand railings, base plates, foundation bolts etc. Purchaser will provide only the foundation with pockets. The bunker shall have shed over it and shall be provided with monorail & hoist for equipment handling.

4.3 The storage bunker shall be so arranged that any 10 ton capacity truck can be conveniently loaded under it by an operator standing on the platform.

4.4 Access and platform shall be provided with 32 mm thick MS grating & 32 mm MS GI pipe hand railing.

4.5 The storage bunker shall be provided with filter bags as specified elsewhere in the specification. Filter bags shall be suitably treated to minimize the chances of filter catching fire. It shall be possible to plug opening for damaged bag filters, if any, to facilitate un-interrupted operation. Suitable explosion vents shall be provided for the bag filter unit. Sequential cleaning cycle shall be initiated with pressure drop signal across the bag filter once sufficient cleaning air pressure is available. Solenoid/pneumatic valves shall be provided for this purpose. Bag cleaning mechanism shall be automatic and shall comprise of solenoid valves. Air nozzles shall be provided just above the filter to facilitate individual cleaning of each bag.

4.6 The terminal boxes for terminating reject conveying pipes shall be of steel construction with necessary deflector or impingement plate to take care of impact and wear due to high velocity reject particles discharging into the bunker.

5.0 INSPECTION AND TESTING

5.1 The purchaser shall have a free access at all reasonable times to these parts of manufacturer's works which are concerned with the fabrication of the steel work and shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of this specification.

5.2 Should any structure or part of a structure be found not to comply with any of the provisions of this specification, it shall be liable to rejection. No structure or part of structure, once rejected shall be resubmitted for inspection/ test except in cases where the purchaser or his authorized representative considers the defect as rectifiable. Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the purchaser. The purchaser may, at his discretion, check the test results obtained at the manufacture's works by independent tests at the government test house or elsewhere and should the material so tested be found to be unsatisfactory shall be rejected. The cost of such tests shall be borne by the contractor.

5.3 Examination of material of construction, verification, correlation and identification with material test certificate.

5.4 Ensuring that the relevant weld procedure and welder qualifications tests are in accordance with fabrication code.

5.5 Inspection during fabrication at appropriate stage including fit up. Witness of dye penetrant testing at root and final run for all groove welds and final run for fillet welds as per ASTM E 165. All surfaces examined shall be free of:

a) Relevant linear indications (Linear indications are those indications in which length is more than three times the width and only indication with major dimension greater than 1.6 mm shall be considered relevant).

b) Four or more rounded defects in a line separated by 1.6 mm or less (edge to edge). Rounded indications are those where length less than three times the width.

5.6 Any other tests as specified in the fabrication code.

5.7 Dimensional check match marking as per approved drawings.

6.0 SCOPE OF INSPECTION FOR RACK AND PINION GATE

6.1 Examination of materials of construction, verification, correlation/testing and identification of material with test certificate for important items like body, drives, warm shaft, rack & pinion, wheel etc.

6.2 Dye Penetration check on drive shaft & warm shaft as per IS-3658 and there shall be no surface defects.

6.3 Dimensional check

6.4 For chain proof load shall be carried out.

6.5 Hardness of rubber component

6.6 Check for overall dimension, completeness, no load working after assembly.

6.7 Clearing, marking and painting.

AIR RECEIVER

1.0 GENERAL

This standard specification covers the design, material of construction, features, manufacture, inspection & testing at VENDOR'S and/or his sub-vendors' works, suitable painting and packing requirements of air receiver

2.0 CODES & STANDARDS

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As far as possible, the design, manufacture and performance of air receivers shall be in accordance with the latest applicable Indian/British/American/DIN standards.

The latest editions of the following shall be followed in particular:

IS: 2825 – Code for unfired pressure vessels

ASME – Section-VIII, Division-1

BS – 487-Fusion welded steel air receivers

IS: 7938 – Air receivers for compressed air installation

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

3.0 DESIGN AND CONSTRUCTION

3.1 The air receivers shall be vertical self-supporting cylindrical vessels with supporting stands for resting on the civil foundation.

3.2 Other design parameters and design internal pressure of the receiver shall be as per the data specification sheet, if any, enclosed. The receiver shall be designed as per IS:7938.

3.3 Receivers shall be of welded construction with a minimum number of joints. Longitudinal seams in adjacent section of shell shall not be in the same line.

3.4 Receivers shall be provided with gasket inspection openings. Receivers below 500 mm diameter shall have at least two inspection holes. For receivers of larger diameter, manhole of minimum 450 mm diameter shall be provided. These openings shall be placed as far as possible from any welded seam and in no instance shall pierce any seam.

3.5 All welding shall be performed in accordance with relevant codes. Filler material that will deposit weld metal with a composition and structure as near as that of the material being welded shall be used. All welding electrodes shall be got approved by the Owner. The electrodes shall be dried in ovens immediately before use to ensure freedom from porosity. All the circumferential and longitudinal butt welds of the air receiver shall be subjected to spot radiography. Tee joints and dished welding shall be subjected to 100% radiography.

3.6 All other welding on the air receiver, including filet weld and nozzle connection shall be DP tested as per IS: 2825 (Para 8.7.11).

3.7 Each finished receiver complete with all welded attachments shall be hydraulically tested at 150% of the design pressure. The test pressure shall be maintained for at least 30 minutes. All joints shall be gentle hammered during the test.

3.8 Receivers shall be provided with relief valve of the capacity and set pressure of the same at least 10% above working pressure. The spring in the relief valve in service for pressure up to and including 250 psi shall not be reset for any pressure more than 10% above or below the design set pressure. For higher pressures, the spring shall not be reset for any pressure more or below 5% design set pressure.

3.9 Each air receiver shall be complete with drain connection of 25 mm NB with a trap station consisting of a trap, strainer, isolation and bypass valves.

3.10 The receiver shall be provided with necessary number of nozzles. The orientation of the nozzles shall be subjected to the approval of the Owner.

3.11 Local instruments like pressure gauge, switch and temp. gauge of suitable range shall be supplied. Please refer specification for conveying air compressor for other instrumentation required.

3.12 The vendor will have all welding procedures & welders qualified in accordance with the relevant codes prior to commencing any welding at the works. These tests shall be witnessed by customer/client representative.

CHAIN PULLEY BLOCK

1.0.0 GENERAL

This specification covers the design**,** manufacture, assembly, inspection and testing at manufacturer's and/or his sub-constructor's works of hand operated chain pulley block.

2.0.0 CODES AND STANDARDS

The design, manufacture, inspection and testing and performance of hand operated chain pulley blocks shall confirm to latest editions of the following standards: -

a) IS: 3832 Specification for hand operated chain pulley block
b) IS 807: 1976 Codes of Practice for Design, Manufacture, Erection and Testing (Structural Portion) of cranes and hoists
c) IS: 3109(Part II) Calibrated load chain for pulley blocks and other lifting appliances
d) IS: 2429(Part II) Calibrated hand chain for pulley blocks and other lifting appliances
e) IS: 4460 Method for rating of machine cut spur and helical gears
f) Material Specification IS or approved

3.0.0 EQUPIMENT

3.1.0 CHAIN PULLEY BLOCK

The block shall be so designed that all components shall withstand without failure, an application to the block of a load equal to at least four times the working load limit.

3.1.1 Frame

Frame shall be robust in design and of welded construction. The frame shall be selected in such a way that head room requirement is minimum. Frame shall maintain alignment under all expected conditions of services.

3.1.2 Chain

The load chain shall be electrically welded, accurately calibrated, and pitched arid polished conforming to IS: 6216 Grade 80 as specified in data sheet 'A'.

The hand chain shall also be electrically welded, calibrated, pitched and polished and shall conform to IS: 2429 (Part II) grade 30. The length of chain and link dimension shall be as per IS: 3832.

3.1.3 Hook

The forged hook shall be properly heat-treated and so designed that in loaded condition, it is free to swivel without twisting the load chain. The hook shall conform to IS: 3815.

3.1.4 Reduction Gear

The reduction gear shall be spur or worm/worm wheel type. The spur gear and worm shall be of high-

grade carbon steel and heat treated. The worm wheel shall be of bronze. A detachable steel cover shall be provided for total enclosure of the gear train and ample lubrication to be provided.

3.1.5 **Brakes**

Brakes shall be of screw friction disc type self-actuating or any other approved type as per manufacturer's standard practice. Brake capacity shall be ample and humid atmosphere shall not affect materials used. The brake shall prevent self lowering of load and arrest and sustain load in all working positions. The load brake shall also allow smooth lowering of the load without serious overheating which may impair sufficient working of block

3.1.6 **Bearing**

Bearing used shall be as per guidelines laid down in IS: 3832.

3.1.7 **Wheel**

The load chain wheel shall be made of heavy duty malleable casting and shall be designed to ensure, effective operation of the chain. Load chain, wheel shall be mounted on two ball bearings. Hand chain wheel shall be made from malleable casting/pressed sheet steel. The idler wheel shall be so shaped as to avoid the twisting of the chain during operation. The P.C.D of idler wheels shall be such that the bending action of the link is avoided. The hand chain wheel shall be provided with flanges and designed to ensure effective operation with hand chain.

3.1.8 **Other components**

All other components of chain pulley block such as anchorage, guide, pawl, stripper etc. shall be designed and provided as per IS: 3832.

3.2.0 MONORAIL TROLLEY

Monorail trolley shall be provided if called for in the enclosed Data Sheet—A. Monorail trolley frame shall be of heavy section rolled steel, held together by bolts. Wheels shall be of high grade cast iron mounted on ball bearings. Axles and shafts shall be of carbon steel, accurately machined and suitably supported. The trolley shall be suitable for variations in I section beams. The trolley shall be geared travel type.

The hand chain required for trolley travel shall be as per clause 3.1.2 of this specification.

Hand chain wheel shall be as per clause 3.1.7 of this specification.

4.0.0 INSPECTION AND TESTING

The scope of inspection shall include but not limited to the following:

a) Material identification/co-relation for important items like hook, load chain, hand chain, wheels, nut and pawl etc.
b) Hardness for pawl and ratchet
c) Dye penetration test for hooks
d) Operational test including operational effort, velocity ratio etc,
e) Proof load test up to 1.5 times of working load limit.
f) Dimensional check of hook

g) Marking

DATASHEET

S. No.	Parameter	Description
1	Capacity (In Kg)	Suitable for lifting the heaviest load but not less than One (1) ton
2	Service condition	Class II outdoor
3	No. of CPB	1 per bunker
4	Lift (m)	To suit bunker height and equipment on bunker roof top to be handled.
5	Type of suspension	Travelling Trolley
6	Head Room	Minimum permissible
7	Type of gear in CPB	Spur Gear
8	Type of bearing	Ball/Roller
9	Grade of Load Chain	Alloy Steel /Gr 80
10	Grade of Hand Chain	Steel / Gr. 30
11	Factor of Safety	As per Relevant IS

Check List for Operation & Maintenance Manual

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				

4.0	Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	Operation Guidelines for plant personal/user/operator				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				

6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)

PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. ‘No smoking’ signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

    a. Rust preventive fluid (RPF)

    b. Rust protective paints

    c. Tarpaulin covers, in case of outdoor storage

    d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

    - Ingress of moisture and corrosion damages.
    - Damage to protective coating.
    - Open ends in pipes, vessels and equipment -
        - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

    - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
    - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere**. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.

ii **Semi-closed storage**. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.

iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

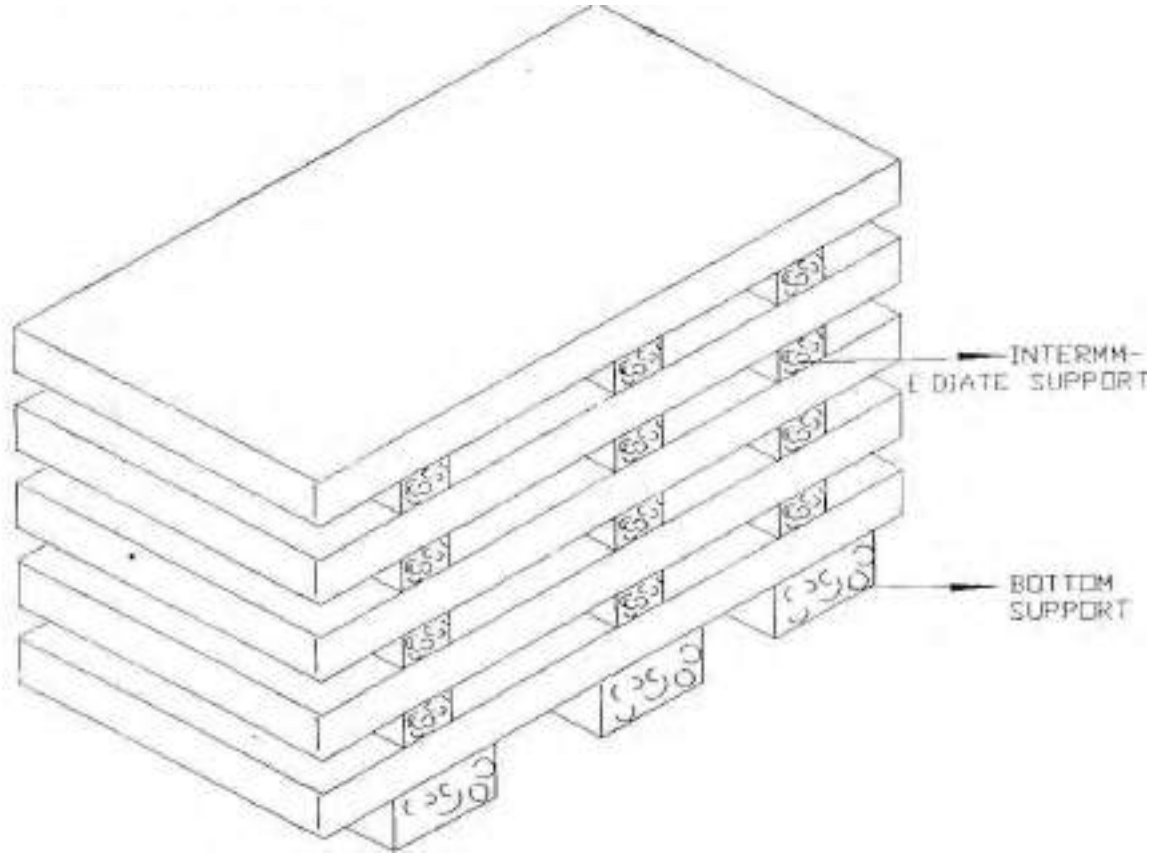

Figure – 1 – PLATE STACKING ARRANGEMENT

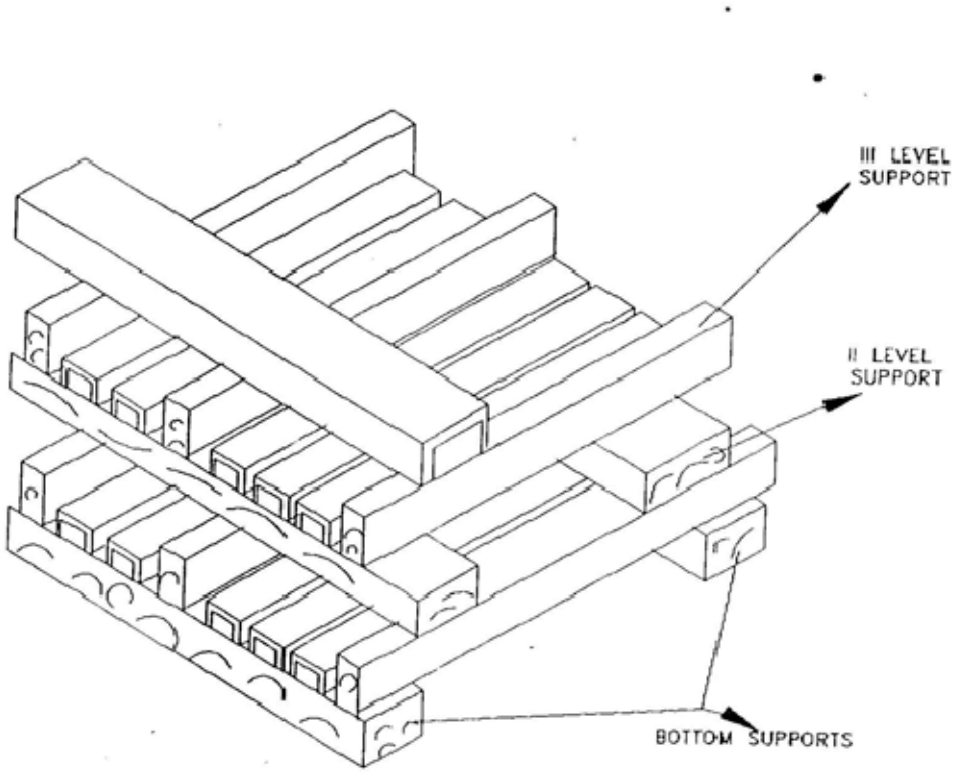

Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

SECTION – III

DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

DRAWINGS/ DOCUMENTS TO BE SUBMITTED WITH THE BID

Bidder shall submit the following drawings/documents along with their bid:

a) Signed and stamped copy of Compliance cum Confirmation Certificate.

b) **Deviation schedule** with reference to specific clauses of the specification along with reason for such deviation in the "Cost of Withdrawal" format attached in the GCC.

Or

No Deviation Certificate

c) Signed and stamped copy of Utility requirement sheet of Section-III.

d) Compliance of filled up Electrical load list. (Section-III)

e) Un-priced copy of price format indicating quoted/ not applicable against each row / column

f) Filled guaranteed power consumption format.

g) As per Annexure- PQR Evaluation given under Section III, PQR evaluation format to be filled and submitted by bidder with relevant PQR credentials.

h) Supply price percentage breakup attached with Section III.

OFFER WILL BE CONSIDERED AS INCOMPLETE IN ABSENCE OF ANY OF ABOVE DOCUMENTS. DOCUMENT OTHER THAN ABOVE, IF ANY, SUBMITTED WITH THE OFFER WILL NOT FORM PART OF CONTRACT AND ACCORDINGLY WILL NOT BE CONSIDERED FOR BID EVALUATION.

COMPLIANCE CUM CONFIRMATION CERTIFICATE

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

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions other than those mentioned under "exclusion" and those resolved as per 'Schedule of Deviations', if applicable, with regard to same.

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

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This shall be within the contracted price with no extra implications to BHEL after award of the contract.

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

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified/ intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre - bid discussions, otherwise BHEL/ Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

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

f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

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

h) Guarantee for plant/equipment shall be as per relevant clause of GCC /SCC /Other Commercial Terms & Conditions.

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities. This clause will apply in case during site commissioning additional requirements emerges due to customer and/ or consultant's comments. No extra claims shall be put on this account.

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to

BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

PRE-BID CLARIFICATION SCHEDULE

S. No.	Section/Clause /Page No.	Statement of the referred clause	Clarification Required

The bidder hereby certifies that above mentioned are the only clarifications required on the technical specification for the subject package.

SIGNATURE:_____

NAME:_____

DESIGNATION:_____

COMPANY: _____

DATE:_____

COMPANY SEAL

UTILITY REQUUIREMENT

S. No.	Description	Quantity	Pressure Requirement	Scope	Tapping
1	DMCW	20 m3/hr	Max inlet pressure (MRS compressor inlet) = 5 Kg/cm2 (g) at 0.00 m EL	BHEL	Tapping with isolation valve, both at inlet and outlet at a distance of 5m from MRS Compressor house.
2	Instrument Air	0.6 m3/min per bay	5-7 Kg/cm2 (g)	BHEL	One 25 NB Tapping at elevation of 3-6 m in each mill bay is required. Location of tapping shall be first col. of mill bay near D row.
3	Service Water	3-4 m3/hr per bay	2.5-3 Kg/cm² (g)	BHEL	One 40 NB Tapping at elevation of 3-6 m in each mill bay is required. Location of tapping shall be first col. of mill bay near D row.

SIGNATURE:_____

NAME:_____

DESIGNATION:_____

COMPANY: _____

COMPANY SEAL

DATE:_____

Section-III E		
2X800 MW UPPUR STPP-MILL REJECT (PNEUMATIC TYPE)		
PERCENTAGE BREAK-UP OF PRICE SHEET		
MAIN SUPPLY		
S.No.	**Details of Works or Equipment/System**	**Price percentage of total ex-works Main Supply price**
1.0	**Break - up of Main Supply Prices (To be used during contract execution for payment)**	
1.1	Lumpsum price of transporter vessel with dome/ butterfly/ vertical swing type valve, insert plates and accessories.	10-15%
1.2	Lumpsum price of pyrite hopper with level probes, RTDs, rupture disc, metallic expansion bellow.	10-15%
1.3	Lumpsum price of pneumatic panel/ air control module/ solenoid box with accessories.	1-5%
1.4	Lumpsum price of storage bunkers, pressure relief valves, bag filters with pressure switch, terminal boxes, level transmitters, chain pulley blocks, bunker discharge gate with accessories.	30-35%
1.5	Lumpsum price of air compressors with drive, etc.	10-15%
1.6	Lumpsum price of air receivers with accessories.	1-5%
1.7	Lumpsum price of pipes for mill reject conveying.	5-10%
1.8	Lumpsum price of pipes for compressed air (instrument air and conveying air) & cooling water services, etc.	1-5%
1.9	Lumpsum price of air & water line valves.	1-5%
1.10	Lumpsum price of pneumatically operated knife gate valves for different application.	1-5%
1.11	Lumpsum price of Alloy CI bends/ fittings/ laterals.	5-10%
1.12	Lumpsum price of field instruments, cable glands & lugs, cable trays/ conduits (branch) as per specification requirement.	1-5%
1.13	Lumpsum price of portable sump pump along with all its control.	0.1-1%
1.14	Total price of erection & commissioning spares and special tools & tackles.	0.1-1%
	Cumulative percentages from 1.1 to 1.14 should be equal to 100%.	**100%**

ANNEXURE-PQR EVALUATION

S. N.	PQR Cl. No.	PQR Requirement	Bidder Reply	Remarks
1	1.0	**Supplier should have capabilities for design/manufacture and having in-house/out-sourced facility for testing of mill reject system (Pneumatic Type) with minimum rated cap. of 3 TPH for plants upto 300MW/minimum rated cap. of 5 TPH for plants above 300MW.**		PQR Criteria: Meeting /Not Meeting
2	2.0	The supplier has to submit either of following supporting documents meeting above mentioned pre-qualifying requirement		PQR Criteria: Meeting /Not Meeting
		a. Copy of minimum one (1) performance certificate in English from end user along with copy of related Purchase Order (PO) or letter of intent (LOI) or letter of award (LOA) or work order (WO) specifying that the system is running successfully for one (1) year from the date of commissioning meeting the minimum pre-qualifying requirement. **OR**		
		b. Minimum two PO/LOI/LOA/WO placed with a minimum gap of one (1) year from same purchaser meeting the minimum pre-qualifying requirement. **OR**		
		c. Minimum one PO/LOI/LOA/WO after commissioning of first order from same purchaser meeting the minimum pre-qualifying requirement. **OR**		
		d. In case, vendor has executed contract(s) for BHEL-PEM, internal assessment by BHEL-PEM shall be followed for evaluation for satisfactory performance. For this, vendor to submit the request along-with relevant documents. **OR**		
		e. Minimum three customer's /third party's inspection reports/test certificates / commissioning certificates meeting the minimum pre-qualifying requirement.		
3.	3.0	Minimum two (2) nos. Purchase orders, shall be submitted which should not be more than twenty (20) years old as on date of bid submission, for establishing continuity in business.		PQR Criteria: Meeting /Not Meeting

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Mill Reject Compressors	80-110 KW		S	2	1	D	U	N	C		MRS compressor house							
Sump Pump (MRS)	2.2-3.7 KW		S	4	0	D	S	N	I		Each mill bay col							
Compressor control Panel	10-15 A		S	3	0	E	S	Y	C									

NOTES:

1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (dc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
   : ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

भेल BHEL	**LOAD DATA (ELECTRICAL)**	JOB NO.	425	ORIGINATING AGENCY	PEM (ELECTRICAL)
		PROJECT TITLE	2X800 MW UPPUR TPS	NAME	DATA FILLED UP ON
		SYSTEM / S	MRS	SIGN.	DATA ENTERED ON
		DEPTT. / SECTION	PEM/ MAX	SHEET 1 OF 1 REV. 00	DE'S SIGN. & DATE

2X800MW UPPUR TPS - Mill Reject Handling System						
GUARANTEED POWER CONSUMPTION FORMAT						
Mode: Pneumatic Conveying						
Sl.No.	**Description / Item**	**Working**	**Standby**	**Power Consumption (KW) (at motor input terminal)**	**Duty Factor**	**Total Power Consumption (KW)**
1	**2**	**3**	**4**	**5**	**6**	**7 = 3 x 5 x 6**
1	Conveying Air Compressor	2	1		**0.50**	
					Total KW	

Notes	
1	**Power consumption (KW) of air compressors shall be measured at motor input terminals when operating at the rated capacity and pressure and performed on test rig at the vendor's works and actual motor shall be used for this purpose.**
2	**<u>The base auxiliary power is 70 KW</u>. Quoted power by bidder at column no. (7) shall be evaluated with respect to base auxiliary power. For bid evaluation purpose, excess power quoted by bidder over base auxiliary power, shall be loaded with Rs. 588401 per KW.**
3	**Power quoted by bidder shall be termed as 'Guaranteed Power consumption' (GPC) and bidder shall be liable to demonstrate compliance to GPC value during PG test/ Demonstration test at site. If the actual power consumption exceeds the guaranteed power consumption, liquidated damages shall be payable by the Contractor at the rate of Rs. 588401 per KW excess power consumption, over the guaranteed power consumption indicated by bidder in his bid. Such liquidated damages may be recovered by the BHEL by deduction from the contract price or by enforcing the contract performance guarantee or in any other manner deemed fit by the BHEL. For this purpose, the drives of standby equipment shall not be considered.**