

**TITLE**

**4 X 270 MW BHADRADRI TPS**  
**TECHNICAL SPECIFICATION FOR**  
**CW/RW/PW CHLORINATION PLANT**

**SPECIFICATION NO.**

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**SECTION C1 – A****SCOPE OF SUPPLY & SERVICES, EXCLUSION AND TERMINAL POINTS ETC.**

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**1.0 INTENT OF SPECIFICATION**

This specification is intended to cover design, engineering, manufacture, assembly, testing at manufacturer's works, forwarding, transportation, delivery to the site, unloading, handling, storage, in plant transportation at site, erection, obtaining clearance from Explosive department, commissioning, trial run, demonstration test and handing over in a flawless operating condition to Purchaser the entire Chlorination Plants complete with all accessories including start-up, commissioning and mandatory spares, filled tonners, auxiliaries and ancillary for CW/RW/PW Chlorination Plant along with Absorption system as per the technical specification number PE-TS-411-174A-A001 for **4X270MW, BHADRARI THERMAL POWER STATION**. The scope of supply shall fully cover the requirement of the Design Criteria and Technical specification of this specification.

**2.0 REFERENCE DOCUMENTS**

- |                              |          |                                                                       |
|------------------------------|----------|-----------------------------------------------------------------------|
| <b>A. ANNEXURE – III</b>     | <b>:</b> | <b>RAW WATER AND CLARIFIED WATER ANALYSIS</b>                         |
| <b>B. PE-DG-411-174-A001</b> | <b>:</b> | <b>P&amp;I DIAGRAM FOR CHLORINATION PLANT &amp; ABSORPTION SYSTEM</b> |
| <b>(Sheet 1, 2, 3 of 3)</b>  |          |                                                                       |
| <b>C. DATASHEET – A</b>      | <b>:</b> | <b>FOR ABOVE SYSTEM (SECTION C1-F)</b>                                |
| <b>D. PE-DG-411-165-N001</b> | <b>:</b> | <b>P &amp; ID OF CW &amp; ACW SYSTEM</b>                              |

**3.0 BORAD SCOPE OF SUPPLY****(REFER FLOW DIAGRAM FOR CW/RW/PW CHLORINATION PLANT)**

Bidder to note that CW/RW/PW chlorination plant shall be a complete system which shall include associated civil design input for all equipment and building. All mechanical, electrical, control & instrumentation work shall be in the scope of bidder. Broad scope of supply has been listed below.

1. Entire CW, RW and PW chlorination plant and absorption system as per P&I diagram (PE-DG-411-174-A001) and datasheet – A.
2. Sixty six (66) nos. (30 nos. for CW Chlorination of unit I & II, 30 nos. for CW Chlorination of unit III & IV and 6 nos. for RW Chlorination) filled chlorine ton containers provided with isolation valves and safety accessories and supporting with roller trunnions brackets for each ton container shall be provided for CW & RW chlorination. All containers shall be filled with pressurized liquid chlorine.
3. Six numbers (6) chlorine manifold (2 nos. for CW Chlorination of unit I & II, 2 nos. for CW Chlorination of unit III & IV and 2 nos. for RW Chlorination) with all accessories for CW & RW chlorination including straight lengths of pipe, fittings, isolation valves, automatic change over facility etc. necessary valves instruments etc. as indicated in P& ID drg. No. PE-DG-411-174-A001 sheet 1 to 3 of 3. For automatic changeover of tonners (liquid withdrawal) shall be provided by bidder.
4. Six (6) numbers. (3 Nos. (2 working+ 1 standby) for unit I & II & 3 Nos. (2 working+ 1 standby) for unit III & IV) electrically heated water bath type evaporators with all accessories shall be provided for CW Chlorination.
5. Pressure reducing and auto shut off valves for each of the chlorine gas line from the outlet of each evaporator shall be provided for CW Chlorination.
6. Two (2) numbers chlorine gas filters for each CW & RW chlorinators.
7. Six (6) nos. liquid expansion chambers fitted with rupture discs, pressure indicator, temperature indicator and pressure switch alarms etc.

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8. Six numbers (6) numbers vacuum solution feed type chlorinator for CW chlorination (3 Nos. (2 working+ 1 standby) for unit I & II & 3 Nos. (2 working+ 1 standby) for unit III & IV) with piping, all accessories inclusive of inlet pressure regulating valves, automatic pressure vacuum relief valve, automatic shut off valves, indicating meter (rota meter), manual chlorine feed rate adjuster, chlorine metering orifice, sensing elements, automatic vacuum differential regulating valve, automatic drain relief valve, spring loaded check valve, injector, vacuum gauge, injector power water supply system etc.
9. Three (3) nos. vacuum solution feed type chlorinator for RW chlorination with piping, all accessories inclusive of inlet pressure regulating valves, automatic pressure vacuum relief valve, automatic shut off valves, indicating meter (rota meter), manual chlorine feed rate adjuster, chlorine metering orifice, sensing elements, automatic vacuum differential regulating valve, automatic drain relief valve, spring loaded check valve, injector, vacuum gauge, injector power water supply system etc.
10. Two (2) nos. cylinder mounted vacuum operated chlorinator with accessories shall be provided for PW chlorination.
11. There shall be three (3) Ejectors (2w+1sb) for CW chlorination for unit I & II, three (3) Ejectors (2w+1sb) for CW chlorination for unit III & IV, three (3) nos. suitable ejectors for RW chlorination and two (2) nos. ejectors with spring-loaded check valve shall be provided with accessories for PW chlorination. Both water and chlorine gas shall be thoroughly mixed in the ejector.
12. Six (6) numbers chlorine water supply booster pumps with driving motors (three (3) nos. for CW chlorination for unit I & II and three (3) nos. for CW chlorination for unit III & IV) along with all accessories to supply water to the chlorinators and evaporators for CW chlorination plants.
13. Three (3) numbers chlorine water supply booster pumps with driving motors along with all accessories to supply water to the chlorinators for RW chlorination plant.
14. Two (2) nos. chlorine water supply booster pumps with driving motors along with all accessories to supply water for PW chlorination plant.
15. Two (2) numbers 2X100% capacity basket strainers with all accessories in suction of each booster pumps.
16. Eight (8) nos. (minimum) diffusers are to be provided (Four (4) nos. diffusers for CW forebay of unit I & II and Four (4) nos. diffusers for CW forebay of unit III & IV) and another twenty four (24) nos. diffusers are to be provided in individual CW pump pit (Twelve (12) nos. diffusers for individual CW pump pit of unit I & II and Twelve (12) nos. diffusers for individual CW pump pit of unit III & IV) as per system requirement & drawing enclosed (PE-DG-411-174-A001), motorised isolation valve (auto) along with necessary accessories with suitable interlock.
17. Two (2) nos. suitable diffuser with counter flange on both sides shall be provided for RW chlorination.
18. One (1) no. suitable diffuser with counter flange on both sides shall be provided for PW chlorination.
19. Three (3) numbers chlorine leak absorption system (One (1) no. for CW chlorination for unit I & II and one (1) no. for CW chlorination for unit III & IV and One (1) no. for RW chlorination) each with (1) number absorption tower with packing, One (1) number caustic solution preparation cum recirculation tank of MSRL having 10 m3 capacity minimum and NaOH concentration shall be 20%, two (2) numbers caustic solution preparation cum recirculation pumps along with one set of (2 x 100% Capacity)

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- centrifugal type blowers with its internals ((i.e) casing, impeller, shaft etc.) FRP lined to protect against corrosion. Blower speed shall be limited to 1500 rpm.
20. All tanks complete with inlet and outlet connections, all fittings and appurtenance etc. as operation.
  21. PLC based control for CW Chlorination. PLC based control for RW chlorination. PW Chlorination shall be DCS controlled (DCS is in BHEL scope).
  22. Minimum Two (2) numbers (1w+1s) exhaust fans for each chlorinator room of CW and RW chlorination. However adequate no. of exhaust fans has to be considered by bidder in their scope as per system requirement in CW, RW and PW chlorinator room **considering 30 air changes per hour for CW, RW & PW chlorination system.**
  23. Chlorine Leak Detector: **5 nos. of chlorine leak detector with four sensors probe for CW chlorination system unit 1 & 2 & 5 nos. of chlorine leak detector with four sensors probe for CW chlorination system unit 3 & 4, 4 nos. of chlorine leak detector with two sensors probe for RW chlorination system & 1 no. of chlorine leak detector with two sensors probe for PW chlorination system shall be provided by bidder.**
  24. Three number (3) of 3T capacity, **each** monorail electric hoist with load indicator with trailing cable operated for lifting ton containers.
  25. Three number weigh scale of 3-ton capacity.
  26. Hangers and supports as per the requirement.
  27. Start-up and commissioning spares as required.
  28. Mandatory Spares as per Annexure-II.
  29. All necessary drains, vents and sampling points with valves as specified and as required.
  30. All piping as required and upto the dosing point as shown in drawing shall be in bidder's scope. Distance between CW Chlorination plant for unit I and II and CW forebay for unit I and II shall be 60m. Distance between CW Chlorination plant for unit III and IV and CW forebay for unit III and IV shall be 60m. This distance doesn't cover the piping required inside respective area **and complete piping for CW chlorination system for unit 1,2,3 & 4 shall be in bidder's scope.**
  31. **Complete Piping required for RW chlorination shall in bidder's scope. Further distance between RW chlorination system & stilling chamber of PT plant shall be approx. 300 m and piping for the same shall be in bidder's scope. This distance doesn't cover the piping required inside RW chlorination system area.**
  32. **Complete piping for PW chlorination plant. Further distance between PW chlorination system & dosing point and motive water suction from potable water transfer pumps to PW chlorination shall be approx. 100 m (each). Piping for both suction from potable water pumps and chlorinated water dosing point for the same shall be in bidder's scope. This distance doesn't cover the piping required inside PW chlorination system area.**
  33. All insert plates, edge angles, puddle pipes, nuts and bolts, counter flanges wherever applicable shall be in the scope of bidder.
  34. Finish paints for touch up painting of equipments after erection at site in sealed container.
  35. Initial charge of all lubricants & grease and first fill of chlorine **in all tonners & cylinders.**
  36. Monitoring gadgets, instruments and equipment required for maintenance (till demonstration test & plant handover).
  37. Safety and supervisory instruments as per specified.
  38. Associated piping and valves required for the system.

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39. All necessary instruments and controls required for easy and safe operation of the system.
40. Wherever terminal points between BHEL and bidder indicated, bidder shall provide pipes with counter flange.
41. Supply and erection of Hand railing as **required** for safety purpose will be in bidder's scope.
42. Bidder will consider 12 m static head + 10% margin in addition to the losses in straight and bend in pipes and valves etc. while selection of pump head **wherever applicable**.
43. Coating, wrapping and protection of buried pipes will be in bidder's scope.
44. All other things are also included in scope of supply as specified in other part of the specification including under design criteria and technical details **as specified in various sections (Section –C & D) of this technical specification**.
45. The pipe sizes indicated in the tender specification/ **P&I** Diagram are minimum. Wherever pipe sizes are not indicated, the same shall be selected based on the specification requirement and shall be subject to BHEL/ customer approval during detailing engineering. All pipes shall be carbon steel unless exclusively mentioned.
46. Pipe racks shall be provided by BHEL wherever available. However where pipe racks are not available the pipe shall run on pipe pedestals All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles shall be in the scope of bidder.
47. All motorized valves shall be provided with integral starter.
48. Wherever terminal points between BHEL and bidder indicated, bidder shall provide pipes with counter flanges.
49. Three nos. (3) Portable residual chlorine analysers.
50. Complete piping indicated in **P&I** diagram of CW, RW and PW chlorination plant is in bidder's scope of supply and erection. In addition, any additional piping required to make the system complete inside chlorination area shall be in bidder's scope.
51. Complete ventilation of Hazardous and Non-hazardous area including toilet for CW, RW, and PW chlorination shall be in scope of bidder.
52. **3 nos. of safety showers shall be provided by bidder 2 nos. for two CW chlorination system and 1 no. for RW chlorination system. Bidder to consider the same while preparing layout.**
53. **For potable water chlorinator bidder to take motive water from the potable water transfer pumps discharge line located in clarified water pump house and dosing point of chlorine solution line for Potable water chlorination shall be in the same line a head (suitable distance) from the tap-off point of motive water. Bidder to consider all piping of PW chlorination system along with counter flanges, tee's, bends & valves. Further any cutting welding of this pipe line is required the same, the same shall be in bidder's scope only.**

**4.0 PAINTING**

The painting of the supplied equipment shall be as per section C1-E of the technical specification only. Painting as per specified above. However, any variation in the painting schedule as finally approved by customer shall be taken care by bidder without any commercial and delivery implication. Colour-coding scheme shall be intimated to vendor during detailed engineering.

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**5.0 SCOPE OF SERVICE**

The bidder's scope also includes following services for scope under this specification:

- a) Erection and commissioning of complete CW, RW & PW chlorination system including Control & Instrumentation, & Electrical work.
- b) Packing, loading, transportation and delivery at site.
- c) Unloading, handling and storage at site.
- d) In-site transportation.
- e) All necessary personnel required during maintenance and Demonstration Test.
- f) Complete routing for equipment, fixing and any concreting inside the tanks and lining.
- g) Arrangement of all Instruments and Lab Facilities, Chemicals and Reagents to carry out trial run/commissioning and Demonstration test.
- h) Commissioning, Trial run for requisite period, Demonstration Test, & Handing over to Customer.
- i) Painting as specified and final touch up paint at site.
- j) Obtaining clearance from Explosive department (CCOE).

**6.0 TERMINAL POINT**

- a) Filtered water( motive water for RW chlorination) : Tap off shall be provided to bidder near 5 m from RW chlorination building from filtered water overhead tank located top of PT chemical house. From this terminal point bidder to consider piping in his scope.
- b) Service water for RW chlorination shall be provided to bidder near 5 m from RW chlorination building. From this terminal point bidder to consider piping in his scope.
- c) Motive water (Circulating water), Service Water for evaporator filling and Instrument Air for CW chlorination: at 5m distance at 0.5m above FGL from CW chlorination buildings for both chlorination plant for Unit I&II and Unit III & IV. From this terminal point bidder to consider piping in his scope.
- d) Potable water (motive water) for PW chlorination terminal point will be near Potable water transfer pumps located in clarified water pump house.

**7.0 CIVIL SCOPE**

- a) **All civil design and construction works are excluded from bidder's scope.** However, all steel inserts, plates, bolts / foundation bolts, nuts, sleeves, edge angle and all other embedding components etc. as required to grout and to hold/support the equipment being supplied under this specification for the chlorination plant shall be in the bidder's scope. **Further complete grouting (civil work) of the equipments shall be in bidder' scope.** However supply and erection of hand railing required in chlorination plant will be in bidder's scope.

**8.0 EXCLUSIONS**

- a) Instrument air up to the terminal point.
- b) Air-conditioning and fire fighting facilities.
- c) All Civil works.
- d) Service water and **filtered water** up to the terminal point.

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**9.0 QUALITY ASSURANCE PLANS**

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

**10.0 SUB VENDOR**

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

**11.0 SPARE**

- i) Start up and Commissioning spares as required will be in the scope of bidder. Bidder will give a list of these spares.
- ii) Mandatory spares shall be supplied as per Annexure-II of the technical specification.

**11.1 MANDATORY SPARES**

- a. The list of mandatory spares which is to be considered by bidder in their scope are indicated in Annexure II.
- b. All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipment.
- c. Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.
- d. Inspection of mandatory spares shall be in line with the approved quality plans for the respective items/equipment. The inspection categorization of mandatory spares shall also be in line with the approved Categorization plan for the respective items/equipment.

**11.2 START-UP & COMMISSIONING SPARES**

- a. Start-up and commissioning spares are those spares which are required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the BHEL/Customer shall come under this category. The Bidder shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at

|                                                                                   |                                                                                                                                         |                                                     |
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site before the equipment are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Bidder.

b. The Bidder shall indicate the service expectancy period for the spares under normal operating conditions before replacement is necessary.

c. All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.

d. All the spares (mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

e. Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

f. All cases, containers or other packages are to be opened for such examination as may be considered necessary by BHEL / Customer.

g. The Bidder will provide the BHEL/Customer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipments covered under the contract and will further ensure with his vendors that the BHEL/Customer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

h. The Bidder shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.

i. The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified.

Any other documents submitted by bidder except as asked in the bid's specification shall not be evaluated & considered as null & void.

**12.0 ADDITIONAL REQUIREMENT**

➤ Bidder to submit BBU during detailed engineering after approval of Basic documents. BBU shall be equal to BOQ for the package and there shall be no price and delivery implication is applicable to BHEL / customer for the same. None of the items supplied for the project as non-billable. Incomplete BBU shall not be review by BHEL.

➤ Any statutory requirement / clearance required for the package from government / local body shall be in bidder's scope.

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- The vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval shall be taken from BHEL. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
- **KKS numbering as per BHEL/Customer requirement shall be provided by the Bidder during detailed engineering stage without any commercial/delivery implication to BHEL/Customer.**
- Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- Buried piping shall be protected as under (as per IS-10221).
  - Surface cleaning by wire brush, power tool cleaning etc.
  - Apply one coat of coal tar/primer/enamel.
  - Apply one layer of tape comprising of coal tar. Application of tape shall conform to AWWA C- 203/IS 10221 (appendix-B) with Minimum thickness of tape as 4MM +10%
- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
- In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.
- Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.

**13.0 DRAWING/DOCUMENTS REQUIREMENT**

13.1 For the Drawings/Documents distribution Procedure, please refer attached Annexure-V. Bidder has to submit the revised drawing/document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. The numbers of soft copies & hard copies of drawing/documents to be submitted by the bidder shall be as per enclosed Annexure-V.

13.2 After award of LOI/LOA, drawing/documents to be submitted by the bidder for BHEL/Customer approval has been indicated in Annexure VI. However any additional drawing/document if found necessary for completion of the

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engineering, the same shall be submitted by bidder  
any commercial & delivery implication to BHEL.

without

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

- Internet explorer version – Minimum Internet Explorer 7
- Internet speed – 2 mbps (Minimum preferred)
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked
- Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)
- DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.

For quick access bidder may refer the link

<http://bhelpem.com/DMSManuals/DMSManuals.html>

## **14.0 CONTROL PHILOSOPHY**

### **RW Chlorination Plant**

The operation of RW chlorination system shall be semi-automatic and envisaged through the PLC based control **system** located in Control Room inside RW Chlorination Building. Each manifold shall have pressure switch which shall be interlocked with an auto changeover valve. The pressure switch shall immediately send a signal to the Auto Changeover Valve for change in direction of flow when the chlorine pressure at operating manifold falls below the set point. This is to ensure uninterrupted flow of chlorine to the system. Annunciation signal shall be provided need to specify that the tonner under service is empty and has to be replaced.

The auto shut-off valve will get closed when the discharge pressure of the Booster Pumps reaches below the set point set point value. The 'Vacuum Switch Low' will give signal to PLC if the system fails to create vacuum. At the same time the 'Pressure Switch Low' provided at the discharge of Booster Pumps will give signal to PLC to close the auto shut-off as addressed above. In the event of chlorine leakage, the Chlorine Leak Detector shall provide alarm and activate the Caustic Circulation Pump (pre-selected via PLC). After preset time delay the Blower (pre-selected via PLC) will start automatically and the process of neutralization shall be set into operation. Dampers of blowers and valves of Caustic Circulation Pump shall be kept open. Chlorinator Room will be properly ventilated by continuously running ventilation fans. When Blowers of Absorption System come into operation through detection of dangerous level of chlorine leakage, the normal ventilation fans should stop and the same will again restart when Blowers stop.

ON/OFF/TRIP status of all pumps, blowers, agitators and drive motors as required, ammeters for drive motors wherever required shall be displayed in PLC workstation. All drive motors shall be provided with arrangement of local starting and stopping. Local starting shall be possible through remote/local selection key in Operating Station or in PLC. Tripping of drive motors locally shall be

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permissible irrespective of position of remote/local selector switch. Provision for locking the local stop push buttons after tripping the motor from local push button shall be provided. All drive motors shall be connected to PLC and the functions described above shall be performed in PLC. Tripping of different motors, level alarms etc. shall also be annunciated.

In addition to that Bidder to refer the P&ID of RW chlorination system to provide necessary control & interlock (various instruments interlock, alarm & annunciation) required for trouble free & safe operation of the RW chlorination system.

### **CW Chlorination Plant**

The operation of CW chlorination system shall be semi-automatic and envisaged through the PLC based control system located in Control Room inside CW Chlorination Buildings (unit 1, 2 separately & Unit 3, 4 separately).

Each manifold shall have pressure switch which shall be interlocked with an auto changeover valve. The pressure switch shall immediately send a signal to operating manifold if pressure falls below the set point to automatic changeover to the other manifold for uninterrupted suction of chlorine. This is to ensure uninterrupted flow of chlorine to the system. Annunciation signal shall be provided need to specify that the tonner under service is empty and has to be replaced. Expansion chamber shall have a pressure switch to provide High Alarm signal in the PLC when the pressure at the inlet of the Evaporator exceeds above the set point value. The solenoid valve at water inlet line of Evaporator shall open/close with reference to low/high water level in Evaporator & temperature high in evaporator.

An alternate connection will also be provided by bidder for filling of evaporator from service water, this line shall include a mortised valve along with an isolation valve, this Motorised valve (provided with limit switch) have an interlock with the low & high level of the evaporator.

The auto shut-off valve will get closed when the temperature of chlorine gas reaches below the set point value or the discharge pressure of the Booster Pumps reaches below the set point set point value.

The 'Vacuum Switch Low' will give signal to PLC If the system fails to create vacuum. In addition to that vacuum switch high shall be also provided by the bidder in this line. At the same time the 'Pressure Switch Low' provided at the discharge of Booster Pumps will give signal to PLC to close the auto shut-off as addressed above. In the event of chlorine leakage, the Chlorine Leak Detector shall provide alarm and activate the Caustic Circulation Pump (pre-selected via PLC). After preset time delay the Blower (pre-selected via PLC) will start automatically and the process of neutralization shall be set into operation. Dampers of blowers and valves of Caustic Circulation Pump shall be kept open. Reading of residual chlorine shall be indicated in Chlorination System PLC to control dosing rate of CW chlorination stream. Chlorinator Room will be properly ventilated by continuously running ventilation fans. When Blowers of Absorption System come into operation through detection of dangerous level of chlorine leakage, the normal ventilation fans should stop and the same will again restart when Blowers stop.

ON/OFF/TRIP status of all pumps, blowers, agitators and drive motors as required, ammeters for drive motors wherever required shall be displayed in PLC workstation.

All drive motors shall be provided with arrangement of local starting and stopping. Local starting shall be possible through remote/local selection key in Operating Station or in PLC. Tripping of

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drive motors locally shall be permissible irrespective of position of remote/local selector switch. Provision for locking the local stop push buttons after tripping the motor from local push button shall be there. All drive motors shall be connected to PLC and the functions described above shall be performed in PLC. Tripping of different motors, level alarms etc. shall also be annunciated.

In addition to that Bidder to refer P&ID of each CW chlorination system to provide necessary control & interlock (various instruments interlock, alarm & annunciation) required for trouble free & safe operation of the CW chlorination system of unit 1, 2 & 3, 4.

**PW Chlorination**

PW Chlorination plant shall be DCS controlled.

Bidder to refer P&ID of each PW chlorination system to provide necessary control & interlock (various valve & instruments for interlock, alarm & annunciation) required for trouble free & safe operation of the PW chlorination system.

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**4 X 270 MW BHADRADRI TPS**  
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Required number of electric hoist / manual hoist of adequate capacity, to meet the erection and maintenance requirements are to be provided for the various areas where handling weight is more than 500 kg.

Manual hoists (hand operated) shall be designed to duty class 2 as per IS 3832 and electric wire rope hoist shall be designed as per IS: 3938 (latest).

The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality act etc. shall however prevail over the specification requirements, in case any conflict arises between this specification and the statutory codes.

Maintenance tools and tackles shall be as per data sheet attached.

**DESIGN CRITERIA**

For the hoists with more than 2.0 tonne lifting capacity and/ or more than 10.0 M lift i.e. either capacity or lift is more than 2T or 10 m, Electrical hoist shall be provided. Less than or equal to 2T and lift  $\leq 10$ m hoist blocks shall be of hand operated type for both travel and lift.

However, all monorails coming out of the building shall be provided with electric hoist block, irrespective of load and lift.

Capacity of electric and manual (Chain pulley block) hoists shall be decided keeping 25% margin over heaviest equipment to be handled.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. For electric hoist, operator shall be able to control the movement of the electrical hoist with the help of floor operated pendant

**Note;**

1. Area, type, capacity mentioned are minimum requirement and shall be finalized during detail engineering without any commercial implication
2. Travel and Lift are layout dependent and shall be finalized during detail engineering without any commercial implication
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

**2.0 SCOPE OF SUPPLIES**

Equipment and services to be furnished by the bidder for the ELECTRIC HOIST/ MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the ELECTRIC HOIST/ MANUAL HOIST complete and efficient operation shall also be under the bidder's scope of work.

Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

**2.1.0 ELECTRIC HOIST**

Electric hoist shall include but not be limited to the following: -

- a. Hoisting and CT drive arrangement
- b. All electrical equipment including cables (as per electrical scope matrix) and panels.
- c. PVC insulated shrouded bus bar DSL

**TITLE**

**4 X 270 MW BHADRADRI TPS**  
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- d. Earthing arrangement.
- e. Fill of lubricant till commissioning / handling over to customer.
- f. Painting of electric hoist and accessories.
- g. Maintenance tools & Tackles
- h. Erection & Commissioning spares
- i. Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the electric hoist.
- j. Mandatory spares

**2.2.0 MANUAL HOIST (CHAIN PULLEY BLOCK)**

Manual hoist shall include but not be limited to the following:

- a. Chain pulley blocks with/without traveling trolleys
- b. Maintenance Tools and Tackles
- c. Mandatory spares

**2.3.0 Erection and Commissioning spares (ELECTRIC HOIST)**

The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. The initial fill of lubricants, oil etc. shall also be supplied by the bidder.

**2.4.0 Services to be provided by the bidder**

Packing, forwarding and transportation to site, storage and handling at site.

**2.5.0 Erection and Commissioning****2.6.0 Functional test (Overload testing, load testing at rated speed, travel and hoisting motion checks as per relevant Indian standards)****2.7.0 Obtaining clearance and acceptance certificate from the concerned competent authority after site test as applicable. Necessary fees/expenditure as required shall be borne by the supplier.****3.0 Inspection and Testing**

Inspection and testing shall be carried out as per enclosed standard quality plan approved QAP and as per IS 3938 (latest revision). Prime inspection agency shall be NBPPL/End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/CHP(Customer Hold Point) at any stage of inspection deemed necessary by Customer/NBPPL during detailed engineering shall be carried out without any commercial or technical implication.

**4.0 Works Excluded**

Supply of ISMB monorail.

**5.0 PAINTING SPECIFICATION**

As per painting details specified elsewhere in specification.

ELECTRIC HOIST COLOR SHADE:

Color shade: Structure: Golden Yellow, RAL 1004

Panel : Opaline green for exterior and semi glossy white for interior

MANUAL HOIST COLOR SHADE:

Trolley: Lemmon yellow (Shade 355 as per IS 5)

Hook: Light grey (Shade 631 as per IS 5)

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**6.0 PACKING**

As per packing details specified elsewhere in specification.

**7.0 DEMONSTRATION TEST**

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.

The bidder shall have the full responsibility for the safe and efficient operation of the hoist with associated accessories as a single unit.

If the shop/site performance tests indicate the failure of any of the components to achieve the guaranteed performance, the deficiency shall be made good at bidder's cost.

Demonstration tests shall be carried out each time after the rectification /modification is carried out.

**8.0 MAKE OF SUB - VENDOR ITEMS**

Makes of bought out items will be as per list specified in the specification. No other make will be acceptable, until and unless specifically got it approved by the purchaser/ end client.

**9.0 TESTING AT SITE****A) ELECTRIC HOIST:**

As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:

- a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavorable conditions;
- b) The correctness of all circuits and interlocks and sequence of operation; and
- c) The satisfactory operation of all protective devices.

Overload Test -After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

**B) MANUAL HOIST:**

As required for statutory clearance for operating at site with following minimum test i.e., overload and load test.

**10.0 Maintenance Tools and Tackles**

One (1) complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual shall be supplied for each EH/CPB. Tools shall be of suitable sizes for maintenance of electric hoist of each type and capacity. Each tool shall be stamped so as to be identified easy for its use. The tools

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shall be supplied in steel toolbox. The items supplied shall be of the best quality, specially protected against rusting. The following shall be provided as minimum requirement:

| S-No. | Description                                                | Qty.  |
|-------|------------------------------------------------------------|-------|
| 1     | Complete set of ring spanners (Indicate the sizes offered) | 1 Set |
| 2     | Complete set of screwdrivers (Indicate the sizes)          | 1 Set |
| 3.    | Adjustable Spanner                                         | 1 No. |
| 4.    | Insulated plier                                            | 1 No. |
| 5.    | Grease gun                                                 | 1 No. |
| 6.    | Oil gun                                                    | 1 No. |
| 7.    | Line tester                                                | 1 No. |

Note:- Bidder shall ensure that the tools & tackles mentioned in above list are sufficient to handle all sizes/capacities of hoists & in case any other /additional tool is required for handling/maintenance any size/capacity of hoist the same shall be included in this list.

**11.0 DRAWING/DOCUMENT SUBMISSION**

The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

**A) ELECTRIC HOIST**

| Sl. No. | BHEL DRG.NO        | DRAWING TITLE                                                       |
|---------|--------------------|---------------------------------------------------------------------|
| 1       | PE-V0-XXX-563-A100 | Manufacturing Quality Plan with Sub vendor list                     |
| 2       | PE-V0-XXX-563-A101 | GA Drawing for Electric Hoist, DSL arrangement and painting details |
| 3       | PE-V0-XXX-563-A102 | Schematic Circuit Diagram                                           |
| 4       | PE-V0-XXX-563-A103 | Mechanism Sizing Calculation                                        |
| 5       | PE-V0-XXX-563-A104 | Detailed BOM/BOQ for EH                                             |
| 6       | PE-V0-XXX-563-A105 | O & M Manual including Erection procedure                           |
| 7       | PE-V0-XXX-563-A106 | Mandatory spare parts list                                          |

**A) MANUAL HOIST (CHAIN PULLEY BLOCK):**

| Sl. No. | BHEL DRG.NO        | DRAWING TITLE                                                           |
|---------|--------------------|-------------------------------------------------------------------------|
| 1       | PE-V0-XXX-563-A200 | Manufacturing Quality Plan                                              |
| 2       | PE-V0-XXX-563-A201 | GA Drawing for Chain Pulley Block with detail BOM with painting details |
| 3       | PE-V0-XXX-563-A202 | O & M Manual including Erection procedure                               |

**Notes;**

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.

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3. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
- All drawings and documents shall indicate the list of all reference drawings including general arrangement.
  - All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.
  - Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
  - All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
  - Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 ....etc.

**12.0 MAKES:****MAKES OF ELECTRIC HOIST AND CHAIN PULLEY BLOCK AS PER LIST BELOW:**

| Package Name       | Vendor Name                        |
|--------------------|------------------------------------|
| ELECTRIC HOIST     | Alpha Services                     |
|                    | CONSOLIDATED HOISTS PVT LTD        |
|                    | CENTURY CRANE ENGINEERS PVT. LTD.  |
|                    | EDDY CRANES PVT. LTD.              |
|                    | Grip Engineers Pvt. Ltd.,          |
|                    | GLOBAL TECHNOLOGIES                |
|                    | HERCULES HOISTS LTD.               |
|                    | LIFTING EQUIPMENTS and ACCESSORIES |
|                    | Mangla Hoists Pvt Ltd              |
|                    | REVA INDUSTRIES LTD.               |
|                    | ROCKWELL HOISTO CRANES PVT. LTD.   |
|                    | SAFEX ENERGY PVT. LTD.             |
| CHAIN PULLEY BLOCK | TUOBRO FURGUSON (INDIA) PVT LTD    |
|                    | ARMSEL MHE PVT. LTD                |
|                    | HERCULES HOISTS LTD.               |
|                    | LIFTING EQUIPMENTS and ACCESSORIES |
|                    | TUOBRO FURGUSON (INDIA) PVT LTD    |
|                    | TRACTEL TIRFOR INDIA PVT. LTD.     |

**Note:** No other make will be acceptable, until and unless specifically got approved by BHEL/Customer / Customer's consultant during detail engineering only. Acceptance/non acceptance of same shall not have any impact on manufacturing, delivery schedule and on cost of the Electric hoists

**MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO ELECTRIC HOIST:**

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**STANDARD LIST OF MAKES OF SUB-VENDOR ITEMS FOR ELECTRIC HOISTS**

| S.NO. | ITEM                    | STANDARD MAKES                                                                                                                 | REMARKS |
|-------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------|---------|
| 1     | STEEL                   | SAIL /TISCO / JINDAL/ ESSAR                                                                                                    |         |
| 2     | HOOKS                   | Steel Forging & Engg. Co., Kolkata/ SIMRITI FORGING/ Karachiwala (up to 25T)                                                   |         |
| 3     | GEAR COUPLINGS          | ALLIANCE / FLEX-TRANS (formerly known as HICLIFF) / OEM / NUTECH/ SAHARA                                                       |         |
| 4     | WIRE ROPE               | USHA MARTIN / FORT WILLIAMS/ Bharat Wire Ropes.                                                                                |         |
| 5     | BEARINGS                | SKF/ FAG/ TATA / NBC                                                                                                           |         |
| 6     | MOTORS                  | SIEMENS / NGEF (up to 15KW) / CROMPTON / KIRLOSKAR / BHARAT BIJLI / MARATHON/ ABB/LHP                                          |         |
| 7     | BRAKES                  | ELECTROMAG /SPEED-O- CONTROL / BCH (for DCEM Brakes only) / Kakku                                                              |         |
| 8     | CONTACTOR               | SIEMENS / L&T /SCHNEIDER (Earlier TELE MECHANIQUE) / BCH                                                                       |         |
| 9     | OVER LOAD RELAYS        | SIEMENS / L&T / ABB / SCHNEIDER (Earlier TELE MACHANIQUE )                                                                     |         |
| 10    | HRC FUSES               | SIEMENS / L&T/ ENGLISH ELECTRIC / GE Power / Eaton (Bussmann)/ABB                                                              |         |
| 11    | ISOLATING SWITCH        | SIEMENS/ L&T/ CONTROL & SWITCH GEAR/ABB                                                                                        |         |
| 12    | SWITCH FUSE UNITS       | SIEMENS/ L&T/ CONTROL & SWITCH GEAR/ ABB                                                                                       |         |
| 13    | TIME DELAY RELAYS       | SIEMENS/ L&T/ ABB/ BCH/ SCHNEIDER (Earlier TELE MACHANIQUE )                                                                   |         |
| 14    | TRANSFORMERS            | INDCOIL / LOGICSTAT/ KAPPA / AUTOMATIC ELECTRIC / PRECISE ELECTRICALS / SILKAAN ELECTRIC MFG. CO. LTD. / SOUTHERN ELECTRIC/NEC |         |
| 15    | CABLE LUGS (HEAVY DUTY) | DOWELLS / UML ENGINEERS, KOLKATA / JAINSON                                                                                     |         |
| 16    | CABLES                  |                                                                                                                                |         |

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**4 X 270 MW BHADRADRI TPS**  
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|    |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|----|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| a) | PVC Power Cables   | APAR INDUSTRIES LTD., CORDS CABLE INDUSTRIES LTD., Diamond Power Infrastructure Ltd, GOYOLENE FIBRES (INDIA) PVT.LTD, GOVIND CABLE INDUSTRIES, GUPTA POWER INFRASTRUCTURE LIMITED,, Havells India Limited, KEI INDUSTRIES LTD., KRISHNA ELECTRICAL INDUSTRIES LTD., KEC INTERNATIONAL LIMITED, MANSFIELD CABLES COMPANY LTD., NICCO CORPORATION LTD., PARAMOUNT COMMUNICATIONS LTD., POLYCAB WIRES PVT. LTD., RADIANT CORPORATION PRIVATE LIMITED, RAVIN CABLES LIMITED, SUYOG ELECTRICALS LTD., SRIRAM CABLES PVT. LTD., Scot Innovation Wires and Cables Pvt. Ltd., Sam Cables & Conductors (P) Ltd., THERMO CABLES LTD.,                                                                                                                                                                                                        |  |
| b) | PVC Control cables | Advance Cable Technologies (P) Ltd., APAR INDUSTRIES LTD., CMI LTD., CORDS CABLE INDUSTRIES LTD., CRYSTAL CABLE INDUSTRIES LTD, DELTON CABLES LTD, Diamond Power Infrastructure Ltd, ELKAY TELELINKS LTD, GEMSCAB INDUSTRIES LTD., GOVIND CABLE INDUSTRIES, GUPTA POWER INFRASTRUCTURE LIMITED,, Havells India Limited, Incom Cables (P) Ltd.,KEI INDUSTRIES LTD., KRISHNA ELECTRICAL INDUSTRIES LTD., KEC INTERNATIONAL LIMITED, MANSFIELD CABLES COMPANY LTD., NICCO CORPORATION LTD., PARAMOUNT COMMUNICATIONS LTD., POLYCAB WIRES PVT. LTD., RAVIN CABLES LIMITED, SUYOG ELECTRICALS LTD., SPECIAL CABLES PVT. LTD, Scot Innovation Wires and Cables Pvt. Ltd., Sam Cables & Conductors (P) Ltd., SPM POWER & TELECOM PVT. LTD,TORRENT CABLES LTD., THERMO CABLES LTD., TIRUPATI PLASTOMATICS PVT. LTD., UNIVERSAL CABLES LTD. |  |
| c) | Trailing Cables    | Nicco / Universal / Incab / ICL / KEI/ APAR INDUSTRIES LTD/ CMI LTD/ KEI INDUSTRIES LTD./ SUYOG ELECTRICALS LTD.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| d) | XLPE Power Cables  | APAR INDUSTRIES LTD., CORDS CABLE INDUSTRIES LTD., CRYSTAL CABLE INDUSTRIES LTD, Diamond Power Infrastructure Ltd, GEMSCAB INDUSTRIES LTD., GOVIND CABLE INDUSTRIES, GUPTA POWER INFRASTRUCTURE LIMITED,, Havells India Limited, KEI INDUSTRIES LTD., KRISHNA ELECTRICAL INDUSTRIES LTD., KEC INTERNATIONAL LIMITED, MANSFIELD CABLES COMPANY LTD., PARAMOUNT COMMUNICATIONS LTD., POLYCAB WIRES PVT. LTD., RAVIN CABLES LIMITED, SUYOG ELECTRICALS LTD., SPECIAL CABLES PVT. LTD, Scot Innovation Wires and Cables Pvt. Ltd., SRIRAM CABLES PVT. LTD.,TORRENT CABLES LTD., THERMO CABLES LTD., TIRUPATI PLASTOMATICS PVT. LTD.,                                                                                                                                                                                                   |  |

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|----|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| e) | XLPE Control cables         | APAR INDUSTRIES LTD., CABLE CORPORATION OF INDIA LTD., CRYSTAL CABLE INDUSTRIES LTD., Diamond Power Infrastructure Ltd, GEMSCAB INDUSTRIES LTD., Havells India Limited, KEI INDUSTRIES LTD., KRISHNA ELECTRICAL INDUSTRIES LTD., KEC INTERNATIONAL LIMITED, PARAMOUNT COMMUNICATIONS LTD., POLYCAB WIRES PVT. LTD., RADIANT CORPORATION PRIVATE LIMITED, RAVIN CABLES LIMITED, SUYOG ELECTRICALS LTD., SRIRAM CABLES PVT. LTD., TORRENT CABLES LTD., UNIVERSAL CABLES LTD. |                                       |
| 17 | Cable gland                 | COMMET / SUNIL&CO./ ARUP ENGINEERING / JAINSON / DOWELL                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |
| 18 | PUSH BUTTONS                | SIEMENS / L&T / BCH / Schneider                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                       |
| 19 | Limit Switches              | Speed-o-control / Electromag                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                       |
| 20 | Pendent Push button station | OEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |
| 21 | Indicating Lamps            | Tecknic / BCH / Siemens / Standard                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                       |
| 22 | MCB                         | MDS / Indo Copp / Standard / Siemens / L&T/ ABB/ Schneider                                                                                                                                                                                                                                                                                                                                                                                                                 |                                       |
| 23 | Panels                      | OEM / RITTAL / PYROTECH                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |
| 24 | Resistance boxes            | Enapros / OEM                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                       |
| 25 | VVVF                        | YASKAWA/ ABB / SIEMENS/ SCHNIEDER/ FUJI ELECTRIC/ MITSUBISHI ELECTRIC                                                                                                                                                                                                                                                                                                                                                                                                      |                                       |
| 26 | Shrouded DSL                | Susheel/ Stromag                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                       |
| 27 | LOAD CELL                   | IPA, Sartorius                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                       |
| 28 | GEAR BOX                    | OEM/ ELECON ENGINEERS/ SHANTI GEARS/ PBL*/ NAW*/ NORD*/ SEW*/ BONGFILIOLI*                                                                                                                                                                                                                                                                                                                                                                                                 | * = Applicable for Geared Motors only |
| 29 | RAIL                        | JSPL / SAIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                       |

Note: 1 All the trailing cables shall be sourced from only one sub-vendor from the list.

2 No other make will be acceptable, until and unless specifically got approved by BHEL/Customer / Customer's consultant during detail engineering only. Acceptance/non acceptance of same shall not have any impact on manufacturing, delivery schedule and on cost of the Electric hoists/ CPB