

**TAMILNADU GENERATION AND DISTRIBUTION CORPORATION  
LIMITED (TANGEDCO)**

**PROJECT: 2x660 MW UDANGUDI TPP-STAGE I**

**TECHNICAL SPECIFICATION  
FOR  
DOUBLE GIRDER EOT CRANES UPTO 100T**

**SPECIFICATION NO.: PE-TS-435-501-A401**



**BHARAT HEAVY ELECTRICALS LTD  
POWER SECTOR PROJECT ENGINEERING MANAGEMENT  
PPEI BUILDING, NOIDA (U.P.)-INDIA**



**TECHNICAL SPECIFICATION FOR  
DOUBLE GIRDER UPTO 100T  
2X660 MW UDANGUDI STPS**

SPECIFICATION NO. PE-TS-435-501-A401

REV 00

DATE MAR 2020

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**SECTION-I**

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**SECTION-I**

**SPECIFIC TECHNICAL REQUIREMENT**

**SUB-SECTION IA**

**SPECIFIC TECHNICAL REQUIREMENT  
(MECHANICAL)**

**SUB-SECTION IB**

**SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)**

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**DATA SHEET A**



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**SUB SECTION-IA**  
**SPECIFIC TECHNICAL REQUIREMENT (MECHANICAL)**



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**SCOPE OF ENQUIRY/INTENT OF SPECIFICATION**

- 1.1 This specification includes, but not limited to **SUPPLY PART, SERVICE PART & MANDATORY SPARES** comprising of design (i.e. preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles fill of lubricants & consumables along with spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, trial run at site and carrying out performance guarantee/Functional/Demonstration tests at site (as applicable), for project and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection & commissioning and load testing of the cranes and its accessories.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.
- 1.5 The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Section-III of the specification within 10 days of receipt of tender documents. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the



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prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

- 1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause in the enclosed deviation schedule along with cost of withdrawal; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or customer including their consultant as interpreted by BHEL in the relevant context. For details refer the relevant clause in GCC.
- 1.12 Apart from specific design requirement for crane, design of various systems/ Sub-systems and all equipment will also strictly meet the stipulations of Customer's Technical Specification.
- 1.13 The standard quality plan is included in this specification to enable the bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the quality plan as minimum along with requirement/s mentioned elsewhere in the specification during manufacturing and testing.



**TITLE :**  
**2 x 660MW UDANGUDI SUPERCRITICAL  
THERMAL POWER PROJECT STAGE-1**

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**SUB-SECTION:**

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## PROJECT INFORMATION

**5.0.0 SITE CONDITION****5.1.0 Location and existing Infrastructure**

The plant location details are as follows:

|                         |                                           |
|-------------------------|-------------------------------------------|
| Country                 | : India                                   |
| State                   | : Tamil Nadu                              |
| Administrative district | : Thoothukudi                             |
| Next big cities to site | : Thoothukudi (approx.45 kms from site)   |
| Road access             | : East Coast Road – State high way (176)  |
| Nearest Railway Station | : Thiruchendur ( approx.12 kms from site) |
| Nearest Airport         | : Vagaikulam (approx.60 kms from site)    |
| Nearest Harbour         | : Tuticorin (approx.45 kms from site)     |

The proposed power project will be located at Udangudi in Tamil Nadu. The proposed power project site is located at about 45km South of Thoothukudi. The proposed marine facilities for the power project will be built on the coast adjoining the power project. The site is accessible by well developed roads.

The town of Tuticorin has all infrastructural facilities and has number of Industries. Tuticorin is well connected by both state highways, National highways and has direct rail link with State Capital Chennai.

**5.1.1 Soil Profile**

A Preliminary soil investigation report and topographical survey has been carried out by Owner. The results are furnished in a separate annexure.

The Detailed geotechnical Investigation and Setting out survey will be performed by the EPC contractor, and will be the basis for the detailed engineering for the project. The geotechnical report shall contain recommendations for foundation design during detailed engineering.

**5.1.2 Seismic intensity**

|                   |   |                         |
|-------------------|---|-------------------------|
| Seismic Intensity | : | As per IS : 1893 Latest |
| Zone              | : | II                      |
| Intensity         | : | As per IS:1893-Latest   |

**5.1.3 Tide Levels**

The recorded tide levels with respect to the Chart Datum (CD) near the identified intake point are as follows:

|                         |              |
|-------------------------|--------------|
| Mean high water-Spring  | CD + 0.99 m  |
| Mean high Water-Neap    | CD + 0.71 m  |
| Mean low Water-Neap     | CD + 0.55 m  |
| Mean low water-Spring   | CD + 0.29m   |
| Mean sea level          | CD + 0.64 m  |
| Highest High Tide Level | CD+ 1.026 m  |
| Lowest Low Tide Level   | CD + 0.110 m |

**5.2.0 Meteorological conditions****Ambient Air Temperature**

Maximum dry bulb temperature : 41 °C

Minimum dry bulb temperature : 17 °C

**Relative humidity**

Mean Maximum humidity (Summer) : 84%

Mean Minimum humidity (Summer) : 62%

Maximum humidity (Monsoon) : 97%

Minimum humidity (Monsoon) : 45%

**Rainfall**

Annual rainfall (Maximum) : 718.2 mm

Annual Rain fall (Minimum) : 384.1 mm

Twenty four (24) Hour max : 138.2 mm

**High Flood Level**

High Flood Level for site : RL 2.450 m

**Wind**

Mean Wind Speed (max) : 20.6 km/h

Wind direction : North, North East, North West, East

The details given are arbitrary and may vary. The contractor should collect the actual data from the Meteorological Department pertaining to the site location and design the plant accordingly.

Meteorological data corresponding to Tuticorin observatory station shall be adopted. These data can be collected from Regional Meteorological Centre, India Meteorological Dept, 50, College Road, Chennai – 600 006.

**5.3.0 Design Requirements related to site conditions****5.3.1 Design Ambient Data****Rainfall data:**

The maximum rainfall in a year to be considered for design is 718.2 mm. 24 hours maximum to be considered is 138.2 mm. Area drainage study as required is in Contractor's scope of work.

**Wind data**

Wind loads to be considered for design of structures shall be based on the design wind speeds arrived at based on IS : 875 (Part -3) – Latest Edition. The parameters for calculation of design wind speed as per IS : 875 (Part -3) – Latest Edition are elaborated under Volume II, Section 5 of Detailed Technical Specification - Civil.



### 5.3.2 Seismic Data

Seismic loads to be considered for design of structures shall be as per as per IS : 1893. Seismic design criteria are elaborated under Volume - II, Section 5 of Detailed Technical Specification- Civil.



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**1.0.0. SCOPE OF WORK**

**1.1.0. SCOPE OF SUPPLY**

1.1.1. Equipment and services to be furnished by the bidder for double girder EOT Cranes upto 100T 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 EOT crane complete for efficient operation shall also be under the bidder's scope of work.

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

1.1.3. Crane shall include but not be limited to the following: -

- a. Bridge girders
- b. End carriages with wheels
- c. Crab (trolley)
- d. Cross Travel & Long Travel drive arrangement
- e. All electrical equipment including cables, junction box, VVVF drive, RRC & pendent and panels etc. as per datasheet A.
- f. PVC insulated shrouded bus bar conductor type DSL
- g. Earthing arrangement
- h. Fill of lubricants till handing over.
- i. Painting of cranes and accessories including touch up painting at site.
- j. Temporary cable of suitable size as per load calculation for commissioning, testing & operation of EOT Crane till such time the DSL is charged.
- k. Rail including all accessories and end stopper suitable for steel gantry girder
- l. Maintenance tools & Tackle
- m. Erection & Commissioning spares
- n. Mandatory Spares (As applicable)
- o. Main Isolating switch/Changeover in enclosure at operating floor for disconnecting supply to DSL. Termination of incoming cable (from BHEL) into isolating switch shall be in Vendor's scope.
- p. Slings and cradle for load testing on returnable basis
- q. Lifting tackles including rope, shackles etc as indicated in specification

**1.1.4 Mandatory Spares**

A complete unused and new set of Mandatory Spare parts shall be supplied. Each part shall be stamped so as to be identified, easy for its use. The items supplied shall be of



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the best quality. The minimum requirement of mandatory spare parts is listed in Annexure –II section-IA of this specification.

**1.1.5 Erection and Commissioning spares**

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. Fill of lubricants; oil etc. till commissioning of the cranes shall also be supplied by the bidder.

**1.1.6 Maintenance Tools and Tackles**

As per Annexure III, section-IA of this specification

**1.1.7 Any supplies/services mentioned in GCC, SCC as relevant to the package**

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

**1.2.1. Packing, forwarding and transportation to site**

**1.2.2. Development of storage space (provided by BHEL) including ward & watch of the equipment and handling at site.**

**1.2.3. Unloading, storage and handling at site.**

The Bidder shall provide means for all unloading and reloading for all consignments of plant; both during transport to Site and on the Site. Consignments shall be unloaded immediately on arrival at Site. The Bidder is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc. The following parts shall be stored inside enclosed warehouses:

Bolts, pins, packing, tools, insulation materials, electrical parts with electrical devices attached, electric motors and excitation equipment, instruments, welding material and equipment, all small parts and all parts of the crane which already have been finally painted. If large parts are stored in the open air, they shall be provided with weather resistant and fire & resistant covers. Electrical parts, which are not packed in heavy duty polyethylene foil and those so packed, but whose packing has been damaged shall be kept in suitable places from the moment of storage to the moment of installation. All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the station shall be protected from weather or humidity. All the equipment shall be stored as per standard storage and preservation instructions etc. of the suppliers.

**1.2.4. Arranging test load at site**



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Collecting the test load at site within a radius of 1-2 KM from owner's storage to final testing bed of crane shall be under bidder's scope of work. Test load in the form of rolled steel, plates, girder, angle etc., as available at the site shall be made available by the purchaser. The test load shall be put back to the place from where it was lifted by the vendor, after the load testing. Load testing sling, cradles and any other item required by the vendor during the load testing shall be arranged by the vendor at no extra cost to the purchaser. Slings & cradles will be allowed to be taken back by the vendor, after completion of the test at site.

1.2.5 Training to customer personal (refer scope included in the technical specification)

1.2.6 Demonstration / Load test at bidder's Works and at site.

1.2.7 Obtaining clearance and acceptance certificate from the concerned competent authority after site test and as and when required as per Government Norms /Statutory body till the time of final handling over to Customer. Necessary fees/expenditure as required shall be borne by the supplier.

1.2.8 Any service mentioned in GCC & SCC as relevant to the package.

**1.3.0 PAINTING & COLOUR SCHEME**

As per Annexure IV, section-IA of this specification

**2.0.0. Drawing and documents submission schedule along with number of prints.**

Drawing and documents submission schedule along with number of prints / copies required for various drawing and documents are listed in Annexure –V, section-IA of this specification.

**3.0.0. Deviations**

If the offer submitted has got any deviation from the technical stipulations in the tender document, bidder shall tabulate the same in the format of "Cost of withdrawal of deviation" attached in Section III / GCC / price schedule indicated in e- procurement portal and furnishing full particular of such deviations. Deviations are to be furnished with mention to specific clause number (reasons / explanations for such deviations shall be furnished). Notes / comments etc. is not acceptable. If there are no deviations from the tender document, bidder shall mention "**NO DEVIATION**" in cost of withdrawal of deviation format.

**4.0.0. Makes of Sub - Vendor items**

Makes of bought out items as per Annexure-I, section IA of the specification is for reference only. Sub vendor list shall be subject to customer approval and same shall not have any impact on manufacturing, delivery schedule and cost of the crane.



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**5.0.0 Parameter and tolerances for structural assembly including rail shall be as per the relevant standards.**

**6.0.0. Performance Test requirement**

EOT crane along with its drives, controls and other accessories shall be checked for the rated capacity against the rated speed of motions and for the service conditions specified.

The bidder shall have the full responsibility for the safe and efficient operation of the crane with associated accessories as a single unit. If the site performance tests indicate the failure of any of the components to achieve the desired performance, the deficiency shall be made good at bidder's cost.

Performance test shall be carried out each time after the rectification /modification is carried out.

Performance test of the crane shall include load tests and speeds in various motions at site.

**7.0.0 Testing of cranes:**

Refer "QUALITY ASSURANCE AND INSPECTION REQUIREMENT" include in the specification.

**8.0.0 Consumables**

The Bidder's scope includes requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. till handing over. Consumption of all these consumables till handing over shall also be included in the scope of the Bidder. Bidder shall also supply a quantity of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilized till handing over. This additional quantity shall be supplied in separate Containers.

**9.0.0 Works Excluded**

- a. Supply feeder and cable from feeder / MCC to isolating switch.
- b. Steel Gantry girder
- c. Dead load for load/ overload testing at site
- d. Space for storage.
- e. Exclusion, if any, mentioned in GCC, SCC.
- f. Access ladder from operating floor to gantry girder walkway



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**QUALITY ASSURANCE AND INSPECTION REQUIREMENT**



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**1.1.0. Inspection and Testing**

Bidder shall submit QAP based on the guidelines given in the specification & QAP enclosed therein.

**1.1.1. Inspection and testing at Manufacturer's works**

Copy of approved documents with stamp and signature (one set) shall be available at the place of Inspection which shall be ensured by supplier.

Shop inspection and tests will include but not limited to the following –

**STAGE INSPECTION**

Stage inspection of various components of crane shall be guided by the MQP approved during detail engineering. Indicative MQP is attached in the specification. However, following shall be ensured and read in conjunction with relevant clause of MQP w.r.t. stage inspection:

- i. All test certificates shall be in original and legible. Photocopies certified by Mill/ manufacturer of raw material used, are acceptable.
- ii. For tensile testing of hooks/ forgings, samples shall be drawn from the full cross section of the shank diameter of hooks/ forgings Samples forged to reduced cross section for testing purposes is not acceptable. **Hooks shall be manufactured from Blooms, billets, rounds by forging with forging ratio of at least 3:1. Hooks manufactured from plates are not acceptable.**
- iii Radiographs shall be inspected to a sensitivity of 2%.
- iv Ultrasonic test on forgings and casting of critical components like cross head (hook suspension block), Hooks, Shafts, Axles, Gears, Wheels, Pulleys etc. Ultrasonic test on forgings shall be carried out as per norms given below. UT shall be carried out in Proof machined condition (single diameter/ Flat surface without steps, keyways, teeth cutting or other profile machining which can create difficulty in ultrasonic testing). Components shall be identified with Heat number and serial number by punching). Hardening operation shall be carried out prior to Ultrasonic testing.

Unacceptable defects in forgings are as given below:

1. Cracks, flakes, seams and laps
2. Defects giving indication larger than '4 (four) mm diameter equivalent flaw' except for wheels for which Defects giving indication larger than '6 (six) mm diameter equivalent flaw.'
3. Group of defects with maximum indication less than that from a 4 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced by 50% except for wheels for which Group of defects with maximum



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indication less than that from a 6 mm dia. equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced by 40%.

4. Defects giving indication of 2 to 4 mm dia. equivalent flaw, separated by a distance less than 4 (four) times the size of the larger of the adjacent flaws except for wheels for which Defects giving indication of 3 to 6 mm dia. Equivalent flaw, separated by a distance less than 4 (four) times the size of the larger of the adjacent flaws Ultrasonic test on Castings shall be carried out as per ASTM E 609.

Wherever, the Quality plan calls for witness of Ultrasonic test by BHEL or BHEL's representative, the material shall be offered for UT in proof machined condition as stated above and hard stamping and subsequent stamp transferring by BHEL shall be followed at subsequent stages to ensure trace ability.

- v. Gear boxes shall be checked at No load for backlash, tooth contact, noise, temperature rise and vibration as per attached Procedure No. PEM (Q)/001.
- vi. Test certificates shall be furnished for verification of Type tests including environmental tests - for electrical and electro-mechanical items. If Type tests for items with similar / identical construction are not available, arrangement shall be made to conduct the same in the presence of BHEL/ Customer's representative (as required).
- vii. Acceptance and routine tests (HV and insulation) for all electrical and electro-mechanical components and system as per governing specification

**FINAL INSPECTION- Testing at Works.**

Cranes shall be completely assembled at manufacturer's works to check the misalignment of gears, shafts and other items. Gears shall be run idle for at least 4 (four) hours. Following minimum tests shall be conducted on the crane at the works of the manufacturer:

- a) Deflection test of bridge girder at rated load. Crane shall rest on centerline of LT wheels.
- b) Load test and Overload test (Hoisting mechanism at 125% of the rated load). Capability of crane to lift the load from mid-air shall be demonstrated at SWL.
- c) Electrical tests for brakes, panel, electrical equipment etc. as per IS - 3177
- d) All Other tests as per IS-3177.

**Testing at site.**

Completely assembled crane at site shall be check for misalignment of gears, shafts and other items. Following minimum tests shall be conducted on the crane at the site



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- i. Deflection test of bridge girder at rated load. Crane shall rest on centerline of LT wheels.
- ii. Load test and Overload test (Hoisting mechanism at 125% of the rated load). Capability of crane to lift the from mid-air shall be demonstrated at SWL. Electrical tests for brakes, panel, electrical equipment etc. as per IS - 3177
- iii. Speed test at rated load for hoisting, CT and LT mechanism.
- iv. Brake test.
- v. Any other test as per IS-3177

**Note:** The test shall be carried out with actual panel, RRC, Master Controller etc.

**Procedure for Load/Overload testing of EOT cranes at Manufacturer's Works & Site**

Refer Testing requirement as mentioned at ANNEXURE-VII.

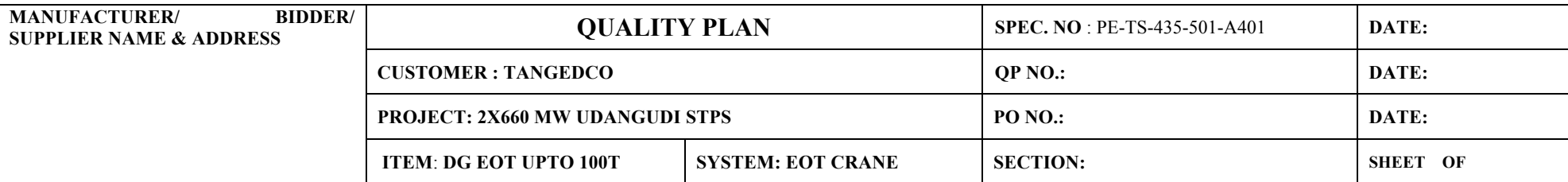
|                                                                                 |                                                          |                                        |                          |                                      |                 |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |                          | <b>SPEC. NO : PE-TS-435-501-A401</b> | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |                          | <b>QP NO.:</b>                       | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |                          | <b>PO NO.:</b>                       | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          | <b>SYSTEM: EOT CRANE</b> | <b>SECTION:</b>                      | <b>SHEET OF</b> |

| SL NO. | COMPONENT & OPERATIONS                                                                | CHARACTERISTICS        | CLASS | TYPE OF CHECK               | QUANTUM OF CHECK |      | REFERENCE DOCUMENT                                                                      | ACCEPTANCE NORMS                                                           | FORMAT OF RECORD |   | AGENCY |      |   | REMARKS                                                                                                                                                                    |
|--------|---------------------------------------------------------------------------------------|------------------------|-------|-----------------------------|------------------|------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|------------------|---|--------|------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | 2                                                                                     | 3                      | 4     | 5                           | 6                |      | 7                                                                                       | 8                                                                          | 9                | * | **     |      |   |                                                                                                                                                                            |
|        |                                                                                       |                        |       |                             | M                | C/ N |                                                                                         |                                                                            |                  | D | M      | C    | N |                                                                                                                                                                            |
| 1.     | <b>RAW MATERIAL</b>                                                                   |                        |       |                             |                  |      |                                                                                         |                                                                            |                  |   |        |      |   |                                                                                                                                                                            |
| a.     | Steel Plates ( Box Girder, End Carriage, Trolley & Gear Casing ,Fabricated Rope Drum) | 1.Chemical & Physical  | Major | Chemical & Physical         | 100%             | -    | CUSTOMER APPD GA DRG./ CRANE DS/TECH SPEC/ IS:2062-2011, GR-BR (E 250/350)              | CUSTOMER APPD GA DRG./ CRANE DS/TECH SPEC/ IS:2062-2011, GR-BR (E 250/350) | T.C.             | √ | P      | #V/W | V | # In absence of co-related TC, check testing shall be witnessed on samples selected by Main contractor                                                                     |
|        |                                                                                       | 2. NDT                 | Major | UT (25mm & above thickness) | 100%             | -    | ASTM A435 / A 578 LEVEL B                                                               | ASTM A435 / A 578 LEVEL B                                                  | I.R.             | √ | P      | #V/W | V | # Co-related Mill TC inclusive of UT will be reviewed by BHEL/CUSTOMER, In absence of UT conformance in Mill TC , then UT will be witness by BHEL.                         |
| b.     | Round Bars (For Pinion ,Gear ,Axles & Shafts)                                         | 1. Chemical & Physical | Major | Chemical & Physical         | 100%             | -    | CUSTOMER appd GA DRG. /CRANE DS /EN-8(080M40), EN-9(070M55), EN-19(709M40),EN-24,BS-970 |                                                                            | T.C.             | √ | P      | V    | V | NOTE: (1) Mech. Properties against H.T condition if applicable against respective Material standard/Grade (2) Hardness test report review after applicable Q & T condition |
|        |                                                                                       | 2. NDT                 | Major | U.T                         | 100%             | -    | ASTM A 388-2007                                                                         | UT PROCEDURE (Attached)                                                    | I.R.             | √ | P      | V    | V |                                                                                                                                                                            |

| BHEL         |             |      |              |             |      |
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|              | Sign & Date | Name |              | Sign & Date | Name |
| Prepared by: |             |      | Checked by:  |             |      |
| Reviewed by: |             |      | Reviewed by: |             |      |

| BIDDER/ SUPPLIER |  |
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| BHEL         |             |      |              |             |      | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |                |
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|              | Sign & Date | Name |              | Sign & Date | Name | Seal             |  |                                | Sign & Date | Name | Seal           |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |  |  |  |                          |  |  | <b>SPEC. NO : PE-TS-435-501-A401</b> |  |  | <b>DATE:</b>    |  |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |  |  |  |                          |  |  | <b>QP NO.:</b>                       |  |  | <b>DATE:</b>    |  |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |  |  |  |                          |  |  | <b>PO NO.:</b>                       |  |  | <b>DATE:</b>    |  |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          |  |  |  | <b>SYSTEM: EOT CRANE</b> |  |  | <b>SECTION:</b>                      |  |  | <b>SHEET OF</b> |  |

|           |                         |                       |       |                                                         |                 |  |                                          |                                          |          |   |   |      |   |                                                                                           |
|-----------|-------------------------|-----------------------|-------|---------------------------------------------------------|-----------------|--|------------------------------------------|------------------------------------------|----------|---|---|------|---|-------------------------------------------------------------------------------------------|
|           |                         | 2.NDT                 | Major | U.T                                                     | 100%            |  | ASTM A 435 / A 578 LEVEL B               | ASTM A 435 / A 578 LEVEL B               | I.R      | √ | P | V    | V |                                                                                           |
|           |                         |                       | Major | Mac ro Etching/Flattening for Seamless Pipe             | 100%            |  | ASTM A 106-2007,GR-B                     | ASTM A 106-2007,GR-B                     | I.R.     | √ | P | V    | V |                                                                                           |
| <b>2.</b> | <b>BOUGHT OUT ITEMS</b> |                       |       |                                                         |                 |  |                                          |                                          |          |   |   |      |   |                                                                                           |
| a.        | Hook                    | Forging Raw material  | Major | Visual Check                                            | 100%            |  | Drg. / Tech. Spec./ IS :1875-1992        | No Visual defect                         | I.R      | — | P | W    | V |                                                                                           |
|           |                         |                       | Major | UT after forging                                        | 100%            |  | ASTM A 388-2007                          | UT PROCEDURE (Attached)                  | I.R      | √ | P | #W   | V | # For MH Hook , UT in proof machined condition and AH Hook in grinding condition.         |
|           |                         | Heat treatment        | Major | Heat treatment after forging                            | 100%            |  | Mfg. Std. / Drg./Tech. Spec./ IS:1875    | Mfg. Std. / Drg./Tech. Spec./ IS:1875    | HT Chart | √ | P | #V/W | V | # HT chart review for Main Hook at mfg. place                                             |
|           |                         | Chemical test         | Major | Chemical integral test piece.                           | Per Heat/ Batch |  | Appd. Drg. / IS :1875 -1992 , CLASS – II | Appd. Drg. / IS :1875 -1992 , CLASS – II | T.C.     | √ | P | V    | V |                                                                                           |
|           |                         | Physical test         | Major | Tensil test on integral test piece after heat treatment | Per Heat/ Batch |  | Appd. Drg. / IS :1875 -1992 , CLASS – II | Appd. Drg. / IS :1875 -1992 , CLASS – II | T.C.     | √ | P | W    | W | Test Piece will be drawn from top of shank portion to be identified by BHEL and CUSTOMER. |
|           |                         | Macro etching         | Major | Grain Size                                              | 100%            |  | ASTM E 112                               | Grain size 6 or final                    | Lab T.C  | √ | P | V    | V |                                                                                           |
|           |                         | NDT before Proof Load | Major | UT                                                      | 100%            |  | ASTM A 388-2007                          | UT PROCEDURE (Attached)                  | I.R      | √ | P | V    | V |                                                                                           |

| BHEL         |             |      |              |             |      |
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| Reviewed by: |             |      | Reviewed by: |             |      |

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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |                          | <b>SPEC. NO : PE-TS-435-501-A401</b> | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |                          | <b>QP NO.:</b>                       | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |                          | <b>PO NO.:</b>                       | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          | <b>SYSTEM: EOT CRANE</b> | <b>SECTION:</b>                      | <b>SHEET OF</b> |

|    |                                                             |                                                           |       |                                                    |      |  |                                                    |                                              |           |   |   |   |        |                     |
|----|-------------------------------------------------------------|-----------------------------------------------------------|-------|----------------------------------------------------|------|--|----------------------------------------------------|----------------------------------------------|-----------|---|---|---|--------|---------------------|
|    |                                                             |                                                           | Major | DPT                                                | 100% |  | ASME Sec V                                         | ASME SEC. VIII , Div-1 , Appendix - 8        | I.R       | √ | P | V | V      |                     |
|    |                                                             | Proof Load Test                                           | Major | Proof Load Test                                    | 100% |  | Drawing / IS: 5749/ IS: 15560 / DS                 | Drawing / IS: 5749/ IS: 15560 / DS           | I.R       | √ | P | W | # V/ W | # W - FOR MAIN HOOK |
|    |                                                             | NDT after Proof Load ( UT only shank portion )            | Major | U.T & MPI after Proof Load Test                    | 100% |  | ASTM A 388-2007 / ASTM E 709-2007                  | ASTM A 388-2007 / ASTM E 709-2007            | I.R       | √ | P | W | # V/ W |                     |
|    |                                                             | Identification Punch                                      | Major | Visual                                             | 100% |  | —                                                  | —                                            | —         | — | P | H | H      |                     |
| b. | Wire Rope & slings                                          | Visual & Breaking Strength                                | Major | Type, grade, breaking strength & visual , Diameter | 100% |  | IS: 2266 – 2002 / G.A DRG / DATA SHEET             | IS: 2266 – 2002 / G.A DRG / DATA SHEET       | Mill T.C. | √ | P | V | V      |                     |
| c. | Rails                                                       | Chemical & Tensile , Cross section , Hardness , Dimension | Major | Chemical & Tensile , Hardness , Dimension          | 100% |  | G.A Drawing / IS: 3443-1980/APPD DATA SHEET        | G.A Drawing / IS: 3443-1980/APPD DATA SHEET  | T.C / I.R | √ | P | V | V      |                     |
| 3. | <b>ELECTRICAL ITEMS</b>                                     |                                                           |       |                                                    |      |  |                                                    |                                              |           |   |   |   |        |                     |
| a. | Transformer ( like Control transformer ,Light transformer ) | Make , Rating                                             | Major | Visual                                             | 100% |  | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS |                                              | IR        |   | P | V | V      |                     |
|    |                                                             | Routine Test                                              | Major | Doc. Review                                        | 100% |  | Mfg. Catalog / DS                                  | IS :2026 & IS: 12021 for control transformer | Mfg. TC   |   | P | V | V      |                     |

| BHEL         |             |      |              |             |      |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |  |                          |  |  | <b>SPEC. NO : PE-TS-435-501-A401</b> |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |  |                          |  |  | <b>QP NO.:</b>                       |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |  |                          |  |  | <b>PO NO.:</b>                       |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          |  | <b>SYSTEM: EOT CRANE</b> |  |  | <b>SECTION:</b>                      |  |  | <b>SHEET OF</b> |  |  |

|    |                                                                                                                                                    |                                                      |       |             |      |  |                                                    |                                        |                                |   |   |   |   |                                                                                            |
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| b. | SFU , MCCB , MCB , CONTRACTORS , DSL, RELAYS , FUSES , RESISTENCE BANK,HOOTER, PUSH BUTTONS, indicating instruments , junction box, Limit Switches | Make / Rating / Type / Size                          | Major | Visual      | 100% |  | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS |                                        | IR                             |   | P | V | V |                                                                                            |
|    |                                                                                                                                                    | Functional / Continuity Check                        | Major | Doc. Review | 100% |  | Drg./ Data Sheet / Relavant Std.                   | Drg./ Data Sheet / Relavant Std.       | IR / COC                       |   | P | V | V | 10% Verification by CUSTOMER                                                               |
| c. | Motor                                                                                                                                              | Type, Rating, Make, Size                             | Major | Visual      | 100% |  | CUSTOMER approved BOI list & ADS / DRG             |                                        | Mfg. TC                        | √ | P | V | V | Refer Note 6 for Motor Up to 50 KW. For Motor above 50 KW separate QP Shall be applicable. |
|    |                                                                                                                                                    | Routine Test / Clearance of QP for Motor above 50 KW | Major | Measurement | 100% |  | IS: 325 / App. Data sheet/CUSTOMER ADS             | IS: 325 / App. Data sheet/CUSTOMER ADS | COC / Mfg T.C. (As per Note-3) | √ | P | V | V |                                                                                            |
| d. | Brakes                                                                                                                                             | Make,Type, Rating                                    | Major | Measurement | 100% |  | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS |                                        | Mfg. TC                        |   | P | V | V |                                                                                            |
|    |                                                                                                                                                    | IR,HV,Functional Test                                | Major | Measurement | 100% |  | MFG. STD.                                          | MFG. STD.                              | Mfg. TC                        |   | P | V | V |                                                                                            |
| e. | VVVF Drive                                                                                                                                         | Type, Rating, Make,                                  | Major | Visual      | 100% |  | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS |                                        | Mfg. TC/ COC                   |   | P | V | V |                                                                                            |
|    |                                                                                                                                                    | Routine Test                                         | Major | Measurement | 100% |  | CUSTOMER APPD DA/GA DRG.                           | CUSTOMER APPD DA/GA DRG.               | Mfg. TC                        | √ | P | V | V |                                                                                            |
| f. | Cables ( Power / Control / Trialing /                                                                                                              | Make, Type, Size                                     | Major | Visual      | 100% |  | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS |                                        | Mfg TC                         |   | P | V | V | Being small quantity of cables used for each                                               |

| BHEL         |             |      |              |             |      | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |                |
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| ENGINEERING  |             |      | QUALITY      |             |      | Sign & Date      |  | Doc No:                        |             |      |                |
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| Prepared by: |             |      | Checked by:  |             |      |                  |  | Reviewed by:                   |             |      | Page 21 of 208 |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |  |                          |  |  | <b>SPEC. NO : PE-TS-435-501-A401</b> |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |  |                          |  |  | <b>QP NO.:</b>                       |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |  |                          |  |  | <b>PO NO.:</b>                       |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          |  | <b>SYSTEM: EOT CRANE</b> |  |  | <b>SECTION:</b>                      |  |  | <b>SHEET OF</b> |  |  |

|    |                                                                                                            |                                    |       |                                                        |      |       |                                                         |                                                         |                   |   |   |     |      |                                                                                          |
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|    | Flexible )                                                                                                 | Routine Test                       | Major | Measurement                                            | 100% |       | CUSTOMER Spec. / IS : 9963 / IS:694 /IS: 1554 / IS:7098 | CUSTOMER Spec. / IS : 9963 / IS:694 /IS: 1554 / IS:7098 | Mfg TC            | √ | P | V   | V    | size and type less than 500 mtr. Separate QAP for cable not required.                    |
| g. | Radio Remote, Master Controller, Pendent Station, Switches                                                 | Make / Rating / Type / Functional  | Major | Visual                                                 | 100% |       | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS      |                                                         | Mfg TC / IR / COC |   | P | V   | V    |                                                                                          |
| h. | Anti - Collision Device , Cable Gland & lugs , Rectifier ,Lamps, load Cell                                 | Make / Type                        | Major | Visual                                                 | 100% |       | CUSTOMER approved BOI list / SLD / DRG / BOM / ADS      |                                                         | Mfg TC / IR / COC |   | P | V   | V    |                                                                                          |
| 4. | OTHER BOUGHT OUT ITEMS                                                                                     |                                    |       |                                                        |      |       |                                                         |                                                         |                   |   |   |     |      |                                                                                          |
|    | Bearings                                                                                                   | Type & Size                        | Major | Verification                                           | 100% |       | Appd.drg./ Mfr’s catalogue                              |                                                         | Mfg TC / IR / COC | √ | P | V   | V    |                                                                                          |
|    | Tools and tackles                                                                                          | Verification of type size / rating | Major | Verification                                           | 100% |       | As per PO / BBU                                         |                                                         | IR / COC          | √ | P | V   | V    |                                                                                          |
|    | Spares (Mandatory / recommended spare / commissioning spares)                                              | Verification of type size / rating | Major | Review Of Internal Inspection Reports / Mfr’s TC / COC | 100% | 100 % | Approved Spare List                                     |                                                         | IR / COC          | √ | P | V/W | V/ W |                                                                                          |
| 5. | IN PROCESS : FABRICATED COMPONENTS : GIRDER, END CARRIAGE, TROLLEY, GEAR BOX CASING , FABRICATED ROPE DRUM |                                    |       |                                                        |      |       |                                                         |                                                         |                   |   |   |     |      |                                                                                          |
| a. | Welding                                                                                                    | WPS & PQR                          | Major | Review of Document                                     | 100% |       | ASME SEC IX 2007                                        | ASME SEC IX 2007                                        | ASME PRO          | √ | P | V   | V    | Earlier CUSTOMER Approved WPS and CUSTOMER / BVQ/Lloyds/EIL qualified Welder acceptable. |

| BHEL         |             |      |              |             |      | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |                |
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| ENGINEERING  |             |      | QUALITY      |             |      | Sign & Date      |  | Doc No:                        |             |      |                |
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| Prepared by: |             |      | Checked by:  |             |      |                  |  | Reviewed by:                   |             |      | Page 22 of 208 |
| Reviewed by: |             |      | Reviewed by: |             |      |                  |  | Approved by:                   |             |      |                |

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|  | <b>MANUFACTURER/ BIDDER/<br/>SUPPLIER NAME &amp; ADDRESS</b> |  | <b>QUALITY PLAN</b>             |  |                   |  |  | SPEC. NO : PE-TS-435-501-A401 |  |  | DATE:    |  |
|                                                                                 |                                                              |  | CUSTOMER : TANGEDCO             |  |                   |  |  | QP NO.:                       |  |  | DATE:    |  |
|                                                                                 |                                                              |  | PROJECT: 2X660 MW UDANGUDI STPS |  |                   |  |  | PO NO.:                       |  |  | DATE:    |  |
|                                                                                 |                                                              |  | ITEM: DG EOT UPTO 100T          |  | SYSTEM: EOT CRANE |  |  | SECTION:                      |  |  | SHEET OF |  |

|    |                                                                                           |                      |       |                                |      |      |                                      |                                            |          |   |   |     |   |                                                                                                                               |
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| b. | Weld Fit Up & Edge Preparation                                                            | Dimension            | Major | Dimension                      | 100% |      | Mfg. Drg.                            | Mfg. Drg.                                  | I.R      |   | P | V   | V |                                                                                                                               |
| c. | Fillet Weld                                                                               | NDT                  | Major | DPT on Fillet Weld             | 100% | 10 % | ASME - Sec. V                        | ASME SEC. VIII , Div-1 , Appendix - 8      | I.R.     | √ | P | V/W | V | DP test of fillet weld for rope drum to be conducted after final machining. Random witness by BHEL                            |
| d. | Butt Weld (Girder ,End-carriage, Trolley & Fabricated Rope drum,if applicable )           | NDT                  | Major | Radiography Test / Gamma Ray   | \$   |      | ASME - Sec. V                        | ASME - Sec. VIII,Div-1, Clause- UW-51 & 52 | I.R.     | √ | P | V   | V | \$ 100% in Tension Zone, 25% in Compression Zone & 100% for rope drum Seam weld, RT Film shall be reviewed by CUSTOMER & BHEL |
|    |                                                                                           |                      |       | DPT on Butt Weld               | 100% | 10%  | ASME - Sec. V                        | ASME SEC. VIII , Div-1 , Appendix - 8      | I.R.     | √ | P | W   | V | 10% random witness by BHEL                                                                                                    |
| e. | Heat Treatment (SR) of Rope drum and Gear Box Casing                                      | —                    | Major | Review of SR chart/Test Report | 100% |      | Drg./ Relavant Std. / CUSTOMER Spec. | Drg./ Relevant Std. / CUSTOMER Spec.       | SR Chart | √ | P | V   | V |                                                                                                                               |
| f. | Cabin (if applicable), Platform, Hand railing                                             | Dimension            | Major | Dimension                      | 100% |      | Mfg. Drg                             | Mfg. Drg                                   | —        | — | P | V   | V |                                                                                                                               |
| g. | Final Inspection of Fabricated Components (Girders, End Carriages & Trolley, end stopper) | Visual & dimensional | Major | Dimensional & Visual Check     | 100% |      | Appd. G.A Drg / CRAB                 | Appd. G.A Drg / CRAB                       | I.R.     |   | P | V   | V | At the Time of Final Insp. Of Crane                                                                                           |
| 6. | IN PROCESS INSPECTION OF MACHINED COMPONENTS                                              |                      |       |                                |      |      |                                      |                                            |          |   |   |     |   |                                                                                                                               |

| BHEL         |             |      |              |             |      |
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| BIDDER/ SUPPLIER |  |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |  |  |                          |  |  | <b>SPEC. NO : PE-TS-435-501-A401</b> |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |  |  |                          |  |  | <b>QP NO.:</b>                       |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |  |  |                          |  |  | <b>PO NO.:</b>                       |  |  | <b>DATE:</b>    |  |  |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          |  |  | <b>SYSTEM: EOT CRANE</b> |  |  | <b>SECTION:</b>                      |  |  | <b>SHEET OF</b> |  |  |

|           |                                         |                           |       |                                    |      |       |                                          |                                          |      |   |   |    |   |                                                                                                                    |
|-----------|-----------------------------------------|---------------------------|-------|------------------------------------|------|-------|------------------------------------------|------------------------------------------|------|---|---|----|---|--------------------------------------------------------------------------------------------------------------------|
| <b>a.</b> | Pinions,Gear & Wheels                   | 1. Dimensional Check      | Major | Measurement                        | 100% |       | Mfg Drg / Crane Data sheet               | Mfg Drg / Crane Data sheet               | I.R  | √ | P | V  | V | Hardness test report review after applicable Q & T condition                                                       |
|           |                                         | 2. Heat Treatment         | Major | Heat Treatment chart               | 100% |       | Material specification/ Mfg std/ Mfg drg | Material specification/ Mfg std/ Mfg drg | I.R  | √ | P | V  | V | Heat treatment Chart to be reviewed by BHEL & CUSTOMER                                                             |
|           |                                         | 3. Hardness               | Major | Measurement                        | 100% | 100 % | Mfg Drg / Crane Data sheet/ IS: 3177     | Material specification/ Mfg std/ Mfg drg | I.R  | √ | P | #W | V | #W - (1) 100% witness for MH/ AH Gear,pinion of entire lot (2) 100% witness for CT & LT Gear, pinion of entire lot |
|           |                                         | 4. NDT                    | Major | DPT on teeth                       | 100% |       | IS:3658-1981 / ASME - Sec. V             | NO CRACKS & LINEAR INDICATION            | I.R  | √ | P | V  | V |                                                                                                                    |
| <b>b.</b> | Difference of Hardness of Pinion & Gear | –                         | Major | Documents review                   | 100% |       | IS 3177 / CUSTOMER apprd. Drg. / DS      | IS 3177 / CUSTOMER apprd. Drg. / DS      | I.R  | √ | P | V  | V |                                                                                                                    |
| <b>c.</b> | Rope Drum                               | 1.NDT & Dimensional Check | Major | DP test on fillet weld & Dimension | 100% |       | ASME SEC VIII Div -1 / Mfg. Drg.         | NO RELEVANT INDICATION                   | I.R. | √ | P | V  | V |                                                                                                                    |
|           |                                         | 2.NDT                     | Major | DP test on Groove after machining  | 100% |       | IS: 3658-1981 / ASME - Sec. V            | NO RELEVANT INDICATION                   | I.R. | √ | P | V  | V |                                                                                                                    |
| <b>d.</b> | Pulley & Brake Drums                    | 1.Visual & dimension      | Major | verification                       | 100% |       | Mfg. Drg                                 | Mfg. Drg                                 | I.R. | √ | P | V  | V |                                                                                                                    |
|           |                                         | 2. NDT                    | Major | DPT after machining                | 100% |       | IS: 3658-1981/ ASME - Sec. V             | NO RELEVANT INDICATION                   | I.R. | √ | P | V  | V |                                                                                                                    |
| <b>e.</b> | Assembled Gear Box                      | 1. Visual & Dimensional   | Major | Visual & dimensional               | 100% |       | As per Mfg Standard / DS / TS            | As per Mfg Standard / DS / TS            | I.R. | √ | P | V  | V |                                                                                                                    |

| BHEL         |             |      |              |             |      |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |  |  |  |                          |  |  | <b>SPEC. NO : PE-TS-435-501-A401</b> |  |  | <b>DATE:</b>    |  |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |  |  |  |                          |  |  | <b>QP NO.:</b>                       |  |  | <b>DATE:</b>    |  |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |  |  |  |                          |  |  | <b>PO NO.:</b>                       |  |  | <b>DATE:</b>    |  |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          |  |  |  | <b>SYSTEM: EOT CRANE</b> |  |  | <b>SECTION:</b>                      |  |  | <b>SHEET OF</b> |  |

|    |                               |                                                                                                                                                      |       |                                                                                             |      |       |                                        |                                        |      |   |   |      |   |                                                                                                                                                                             |
|----|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------|------|-------|----------------------------------------|----------------------------------------|------|---|---|------|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                               | 2. NDT                                                                                                                                               | Major | DPT on Fillet Weld                                                                          | 100% |       | IS: 3658-1981 / ASME - Sec. V          | NO RELEVANT INDICATION                 | I.R  | √ | P | V    | V |                                                                                                                                                                             |
|    |                               | 3. Mechanical                                                                                                                                        | Major | Backlash ,Contact Pattern                                                                   | 100% |       | Approved Drawing /Data Sheet/Mfg. Std. | Approved Drawing /Data Sheet/Mfg. Std. |      | √ | P | V    | V |                                                                                                                                                                             |
|    |                               |                                                                                                                                                      | Major | Reduction Ratio , No Load Run Test For Check of Oil Leakage / Temp. Rise, Vibration & Noise | 100% | 100 % | Approved Drawing /Data Sheet/Mfg. Std  | Approved Drawing /Data Sheet/Mfg. Std  | I.R. | √ | P | #V/W | V | NOISE Max.85 db at 1 mtr. & 30° C temp. rise at ambient # W - for Main hoist and Aux. Hoist Gear box                                                                        |
| f. | DSL Guard                     | Dimensional                                                                                                                                          | Major | Dimension                                                                                   | 100% |       | Mfg. Drg.                              | Mfg. Drg.                              | I.R. |   | P | V    | V |                                                                                                                                                                             |
| 7. | <b>FINAL INSPECTION</b>       |                                                                                                                                                      |       |                                                                                             |      |       |                                        |                                        |      |   |   |      |   |                                                                                                                                                                             |
| a. | CONTROL PANEL With VVVF Drive | Identification of all Elect. Components , Cable laying / Dressing/Feruling /Terminations Dimensional Functional , HV, IR, interlocks, Protection DOP | Major | Visual, dimensional, Operational & Functional Check , HV,IR, Painting                       | 100% | 100 % | IS:3177 -1999 / Appd. Drg / Data sheet | IS:3177 -1999 / Appd. Drg / Data sheet | T.C  | √ | P | W    | W | (HV at 2.5 KV Ac for power ckt at 2 KV for control ckt ,DOP by paper insertion method) BOI as per CUSTOMER Approved Makes. Will be Checked at the time of Final Inspection. |
|    |                               | Paint Shade/ Thk/ Adhesion                                                                                                                           | Major | Visual / DFT Check                                                                          | 100% |       | APPD Painting Procedure / GA           | APPD Painting Procedure / GA           | T.C  |   | P | V    | V | 7 Tank Pretreatment before Painting                                                                                                                                         |

| BHEL         |             |      |              |             |      |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |                          | <b>SPEC. NO : PE-TS-435-501-A401</b> | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |                          | <b>QP NO.:</b>                       | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |                          | <b>PO NO.:</b>                       | <b>DATE:</b>    |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          | <b>SYSTEM: EOT CRANE</b> | <b>SECTION:</b>                      | <b>SHEET OF</b> |

|           |                                                                                     |                      |       |                                                                                                                                                                                                                                                                                                 |      |       |                                                         |                                                         |      |   |   |   |   |                                                                          |
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| <b>b.</b> | EOT crane assembly with control panel, Remote Controller Pendant Station (At Works) | Visual & dimensional | Major | Dimensional ,Span, Diagonal & Wheel Base Dimension, LT Stopper Dimension                                                                                                                                                                                                                        | 100% | 100 % | Approved G.A. Drg. / IS 3177 / DS                       | Approved G.A. Drg. / IS 3177 / DS                       | I.R. | √ | P | W | W | Crane Should be Operable by RRC meant for that Crane only.               |
|           |                                                                                     | Operational          | Major | (1) Speed & Current Measurement at No Load for Hoist & CT/LT motion<br>(2) Speed & Current measurement at SWL of Hoist & CT motion<br>(3) Over load test (125%) of SWL for Hoist motion<br>(4) Deflection test at SWL<br>(5) Operation Check of Brake at SWL<br>(6) Interlock & Functional test | 100% | 100 % | Approved G.A. Drg. / IS 3177 / Load test procedure / DS | Approved G.A. Drg. / IS 3177 / Load test procedure / DS | I.R. | √ | P | W | W | Functional & Interlock test as per approved Electrical Schematic drawing |
| <b>8.</b> | Lifting beam ( for tandem operation) at works                                       | Measureme nt         | Major | Dimension, Visual and load /overload test                                                                                                                                                                                                                                                       | 100% | 100 % | Approved G.A. Drg. / IS 3177 / Load test procedure / DS | Approved G.A. Drg. / IS 3177 / Load test procedure / DS | IR   | √ | P | W | W |                                                                          |
| <b>9.</b> | Cleaning & painting                                                                 | Paint Shade / DFT    | Major | Visual , DFT Check                                                                                                                                                                                                                                                                              | 100% |       | Painting Scheme / DS / TS                               | Painting Scheme / DS / TS                               | IR   | √ | P | V | V |                                                                          |

| BHEL         |             |      |              |             |      |
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|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>QUALITY PLAN</b>                    |  |  |                          |  | <b>SPEC. NO : PE-TS-435-501-A401</b> |                 |  | <b>DATE:</b> |                 |  |
|                                                                                 |                                                          | <b>CUSTOMER : TANGEDCO</b>             |  |  |                          |  | <b>QP NO.:</b>                       |                 |  | <b>DATE:</b> |                 |  |
|                                                                                 |                                                          | <b>PROJECT: 2X660 MW UDANGUDI STPS</b> |  |  |                          |  | <b>PO NO.:</b>                       |                 |  | <b>DATE:</b> |                 |  |
|                                                                                 |                                                          | <b>ITEM: DG EOT UPTO 100T</b>          |  |  | <b>SYSTEM: EOT CRANE</b> |  |                                      | <b>SECTION:</b> |  |              | <b>SHEET OF</b> |  |

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| <b>10.</b> | Review of QA documentation |                   |       |                       |      |  | As per approved QAP                    |    |   | V | V | V |  |
| <b>11.</b> | Packing of components      | Visual inspection | Major | Visual                | 100% |  | BOM / Elec. DODL Packing specification | IR | √ | P | V | V |  |
| <b>12.</b> | Mandatory spares           | Visual inspection | Major | Visual / Verification | 100% |  | Approved mandatory spare list          |    | √ | P | W | V |  |

**NOTE :**

- 1) Original TCs / Photocopies certified in original by mill shall be furnished for review. Test In absence of correlated TCs Check test shall be carried out from each plate/ bar for above 10 mm thk., certificates shall be offered for review at the time of stage inspection of components / assembly. Supplier shall ensure that pitted material is not used.
- 2) X-Ray to be taken for thickness upto 19 mm and Gamma Ray for thickness above 19 mm. If Gamma Ray is used for lower thickness slow speed film like D2 or equivalent which gives enough readable and interpretable film quality to be used for clarity. All NDT shall be carried out by Qualified Level II personnel.
- 3) Performance of electrical & control devices along with the interlocks, protection & sequence to be checked during crane assembly and parked at works.
- 4) Acceptance norms for UT (Normal probe to be used of not less than 2 MHz frequency) : Following defects are not acceptable:/ Vendor's UT Procedure approved by BHEL may also be used.
  - (i) Cracks, flakes, seams and laps
  - (ii) Defects giving indications larger than 6 mm diameter equivalent flaw.
  - (iii) Groups of defects with maximum indication less than that from a 6 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 40%.
  - (iv) Defects giving indications of 3 to 6 mm diameter equivalent flaw separated by a distance less than four time the length of the larger of the adjacent flaws
- 5) Acceptance norms for UT (Normal probe to be used of not less than 2 MHz frequency) : Following defects are not acceptable:/ Vendor's UT Procedure approved by BHEL may also be used.
  - (i) Cracks, flakes, seams and laps
  - (ii) Defects giving indications larger than 4 mm diameter equivalent flaw.
  - (iii) Groups of defects with maximum indication less than that from a 4 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 50%.
  - (iv) Defects giving indications of 2 to 4 mm diameter equivalent flaw separated by a distance less than four time the size of the larger of the adjacent flaws

For hooks, for carrying out UT on the areas where there is loss of back wall echo due to geometry, the calibration shall be done on blocks of same material of similar thickness having Flat Bottom holes of required size as given above.
- 6) FOR MOTORS, FOLLOWING MODALITIES SHALL BE ADOPTED.
  - (A) LESS THAN 30KW : ACCEPTANCE OF MOTOR LESS THAN 30 KW IS BASED ON COC OF THE MANUFACTURER & THE CONTRACTOR CONFIRMING AS FOLLOWS:
    - IT IS HEREBY CONFIRMED THAT THE ABOVE MENTIONED MOTOR /MOTORS WAS/ WERE MANUFACTURED TAKING CARE OF CUSTOMER SPECIFIC REQUIREMENTS REGARDING AMBIENT TEMP., VOLTAGE & FREQUENCY VARIATION, HOT STARTS, PULL OUT TORQUE, STARTING KVA/KW, TEMP. RISE, DISTANCE BETWEEN CENTRE OF STUD & GLAND PLATE AND TESTED IN ACCORDANCE WITH APPROVED DRAWING /DATA SHEETS.
  - (B) 30 KW TO BELOW 50 KW
    - ACCEPTANCE OF MOTOR RATING BETWEEN 30 KW & 50 KW IS BASED ON CUSTOMER REVIEW OF ROUTINE TEST INSPECTION REPORT AS PER IS 325 ALONG WITH COC OF THE MANUFACTURER & THE CONTRACTOR CONFIRMING AS FOLLOWS:

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

| BHEL         |             |      |              |             |      | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |                |
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| ENGINEERING  |             |      | QUALITY      |             |      | Sign & Date      |  | Doc No:                        |             |      |                |
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| <br>PSSR-QUALITY | SUPPLIER'S NAME & ADDRESS | STANDARD FIELD QUALITY PLAN |            |       |                                                |                                        |                  |         |
|-------------------------------------------------------------------------------------------------|---------------------------|-----------------------------|------------|-------|------------------------------------------------|----------------------------------------|------------------|---------|
|                                                                                                 |                           | SYSTEM : EOT Crane          |            |       | QP NO. :<br>REV. No. : 00<br>PAGE No. : 1 of 4 |                                        |                  |         |
| SL.NO.                                                                                          | CHARACTERISTICS / ITEM    | TYPE OF CHECK               | INSTRUMENT | CLASS | QUANTUM / FREQUENCY OF CHECK                   | REFERENCE DOCUMENT/ ACCETANCE STANDARD | FORMAT OF RECORD | REMARKS |

|   |                                                                                                                                                                                                   |                     |                   |   |      |                                   |          |  |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------|---|------|-----------------------------------|----------|--|
| 1 | RECEIPT & STORAGE<br>EOT Crane after arrival at site.<br>a. Check manufacturers dispatch documents at site, MDCC, CHP etc. for completeness, identification.                                      | Record Verification | Visual            | B | 100% | Drawings / Tech. Spec.            | Protocol |  |
|   | b. Check for coating condition of rust inhibitor check and any transit damage                                                                                                                     | Visual              | Visual            | B | 100% | Drawings/Tech. Spec/ No. Damage   | Protocol |  |
|   | c. Storage condition of parts, rails, crane girders and structural parts shall be placed on the elevated surface.<br>* Gear box, fasteners and wire ropes shall be stored in closed covered shed. | Physical            | Visual            | B | 100% | Storage & Preservation Procedure. | Protocol |  |
|   | d. Electrical items like panel, cables, motor, controls & resistance block in closed, covered shed.                                                                                               | Physical            | Visual            | B | 100% | Storage & Preservation Manual     | Protocol |  |
| 2 | PRE-ERECTION CHECK                                                                                                                                                                                |                     |                   |   |      |                                   |          |  |
|   | a. For Gantry at every 5.0 M i.e. span, level, diagonals before taking over from Client                                                                                                           | Measurement         | Tape, Water level | A | 100% | Drawings                          | Protocol |  |
|   | b. Web axes of gantry girders in a row are aligned.                                                                                                                                               | Measurement         | Water level       | B | 100% | Drawings/ER Manual                | Protocol |  |
|   | c. Center to center distance of gantry girders.                                                                                                                                                   | Measurement         | Measuring Tape    | B | 100% | Drawings/ER Manual                | Protocol |  |

|                                                                                                                                                                                                                                                                                                                                   |              |                          |                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------|------------------|
| <b>LEGEND : CLASS #:: A = CRITICAL, B = MAJOR, C = MINOR</b><br><b>"A" SHALL BE WITNESSED BY BHEL &amp; CUSTOMER/ CLIENT</b><br><b>"B" SHALL BE WITNESSED BY BHEL</b><br><b>"C" SHALL BE WITNESSED BY ERECTION ENGINEER</b><br><br><b>TYPE @ : V = VISUAL, R = RECORD VERIFICATION, M= MEASUREMENT, P = PHYSICAL &amp; T-TEST</b> | FOR BHEL USE | FOR BHEL USE             | FOR CUSTOMER USE |
|                                                                                                                                                                                                                                                                                                                                   | PREPARED BY  | REVIEWED AND APPROVED BY | APPROVED BY      |

| <br>PSSR-QUALITY | SUPPLIER'S NAME & ADDRESS | STANDARD FIELD QUALITY PLAN |                                                |       |                              |                                        |                  |         |
|-------------------------------------------------------------------------------------------------|---------------------------|-----------------------------|------------------------------------------------|-------|------------------------------|----------------------------------------|------------------|---------|
|                                                                                                 |                           | SYSTEM : EOT Crane          | QP NO. :<br>REV. No. : 00<br>PAGE No. : 2 of 4 |       |                              |                                        |                  |         |
| SL.NO.                                                                                          | CHARACTERISTICS / ITEM    | TYPE OF CHECK               | INSTRUMENT                                     | CLASS | QUANTUM / FREQUENCY OF CHECK | REFERENCE DOCUMENT/ ACCETANCE STANDARD | FORMAT OF RECORD | REMARKS |

|   |                                                                                                               |             |                             |   |      |                          |          |  |
|---|---------------------------------------------------------------------------------------------------------------|-------------|-----------------------------|---|------|--------------------------|----------|--|
| 3 | Check for Alignment of Rails                                                                                  |             |                             |   |      |                          |          |  |
|   | a. Straightness of gantry rails                                                                               | Measurement | Piano Wire/ Twine           | B | 100% | Drawings/Erection Manual | Protocol |  |
|   | b. Level and Elevation of Gantry rails (top level of girder)                                                  | Measurement | Water level/ Measuring Tape | A | 100% | Drawings/Erection Manual | Protocol |  |
|   | c. Distance between rails(every 5 M) (Tolerance.±. 6mm) including diagonal of gantry rails (Tolerance±. 5 mm) | Measurement | Measuring Tape              | A | 100% | Drawings/Erection Manual | Protocol |  |
|   | d. Bolting of rails and tightening                                                                            | Measurement | Torque wrench               | C | 100% | Drawings                 | Protocol |  |
| 4 | e. End Stopper Arrangement                                                                                    | Physical    | -                           | A | 100% | Drawing                  | Protocol |  |
|   | ERECTION CHECK FOR                                                                                            |             |                             |   |      |                          |          |  |
|   | a. Joining of Girders i.e. splice joints                                                                      | Physical    | -                           | B | 100% | Tech. Spec.              | Protocol |  |
|   | b. Placement of girder assembly on the gantry.                                                                | Physical    | -                           | B | 100% | Drawings/Tech Spec.      | Protocol |  |
|   | c. Movement of wheels                                                                                         | Physical    | -                           | B | 100% | Drawings/Tech Spec.      | Protocol |  |
|   | d. Placement and positioning of electrical panel & trolley.                                                   | Physical    | -                           | B | 100% | Drawings/Tech Spec.      | Protocol |  |
|   |                                                                                                               |             |                             |   |      |                          |          |  |

|                                                                                                                                                                                                                                                                                                                                             |              |                          |                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------|------------------|
| <b>LEGEND : CLASS #:: A = CRITICAL, B = MAJOR, C = MINOR</b><br><b>"A" SHALL BE WITNESSED BY BHEL &amp; CUSTOMER/ CLIENT</b><br><b>"B" SHALL BE WITNESSED BY BHEL</b><br><b>"C" SHALL BE WITNESSED BY ERECTION ENGINEER</b><br><br><b>TYPE @ : V = VISUAL, R = RECORD VERIFICATION,</b><br><b>M= MEASUREMENT, P = PHYSICAL &amp; T-TEST</b> | FOR BHEL USE | FOR BHEL USE             | FOR CUSTOMER USE |
|                                                                                                                                                                                                                                                                                                                                             | PREPARED BY  | REVIEWED AND APPROVED BY | APPROVED BY      |

| <br>PSSR-QUALITY |                                                                                                                      | SUPPLIER'S NAME & ADDRESS |                     | STANDARD FIELD QUALITY PLAN |                              |                                                |                  |         |  |
|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------|-----------------------------|------------------------------|------------------------------------------------|------------------|---------|--|
|                                                                                                 |                                                                                                                      |                           |                     | SYSTEM : EOT Crane          |                              | QP NO. :<br>REV. No. : 00<br>PAGE No. : 3 of 4 |                  |         |  |
| SL.NO.                                                                                          | CHARACTERISTICS / ITEM                                                                                               | TYPE OF CHECK             | INSTRUMENT          | CLASS                       | QUANTUM / FREQUENCY OF CHECK | REFERENCE DOCUMENT/ ACCETANCE STANDARD         | FORMAT OF RECORD | REMARKS |  |
| 5                                                                                               | e. Movement of crab trolley on the crane girder                                                                      | Physical                  | -                   | B                           | 100%                         | Drawings/Tech Spec.                            | Protocol         |         |  |
|                                                                                                 | f. Deviation in the crane rail level at any point from true level tolerance $\pm 10$ mm                              | Measurement               | Piano Wire / Twince | A                           | 100%                         | Drawings/ Erection Manual                      | Protocol         |         |  |
|                                                                                                 | D.S.L.                                                                                                               |                           |                     |                             |                              |                                                |                  |         |  |
|                                                                                                 | a. Fixing arrangement                                                                                                | Visual                    | -                   | C                           | 100%                         | Drawing                                        | Protocol         |         |  |
|                                                                                                 | b. Location with respect to gantry rail, spacing & alignment.                                                        | Measurement               | Measuring Tape      | B                           | 100%                         | Drawing                                        | Protocol         |         |  |
| 6                                                                                               | c. Continuity check & insulation Resistance                                                                          | Measurement               | Megger              | A                           | 100%                         | Minimum 5 Mega Ohms                            | Protocol         |         |  |
|                                                                                                 | Cable laying connections                                                                                             | Physical                  | -                   | B                           | 100%                         | Drawing                                        | Protocol         |         |  |
| 7                                                                                               | Crab Clearances                                                                                                      |                           |                     |                             |                              |                                                |                  |         |  |
|                                                                                                 | a. Headroom, end clearance, hook approaches and height of lift and record.                                           | Visual & Measurement      | Measuring Tape      | B                           | 100%                         | Drawing                                        | Protocol         |         |  |
| 8                                                                                               | Gear Box                                                                                                             |                           |                     |                             |                              |                                                |                  |         |  |
|                                                                                                 | a.Check oil level                                                                                                    | Measurement               | Dip stick           | B                           | 100%                         | Drawing                                        | Site log Book    |         |  |
| 9                                                                                               | LT Machinery, Platform, cabin, Electrical equipment, other structural components, limit switch & Mechanical stopper. |                           |                     |                             |                              |                                                |                  |         |  |
|                                                                                                 | a. Fit up                                                                                                            | Visual                    | -                   | B                           | 100%                         |                                                | Protocol         |         |  |
|                                                                                                 | b. Alignment                                                                                                         | Visual                    | -                   | B                           | 100%                         | Drawing                                        | Protocol         |         |  |
| 10                                                                                              | Storm braker arrangement                                                                                             | Physical                  | -                   | A                           | 100%                         | Drawing                                        | Protocol         |         |  |
| 11                                                                                              | COMMISSIONING CHECKS                                                                                                 |                           |                     |                             |                              |                                                |                  |         |  |

|                                                                                                                                                                                                                                                                                                                                             |                                               |                                                            |                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------|---------------------------------------------------|
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| <br>PSSR-QUALITY | SUPPLIER'S NAME & ADDRESS | STANDARD FIELD QUALITY PLAN |            |       |                                                |                                        |                  |         |
|-------------------------------------------------------------------------------------------------|---------------------------|-----------------------------|------------|-------|------------------------------------------------|----------------------------------------|------------------|---------|
|                                                                                                 |                           | SYSTEM : EOT Crane          |            |       | QP NO. :<br>REV. No. : 00<br>PAGE No. : 4 of 4 |                                        |                  |         |
| SL.NO.                                                                                          | CHARACTERISTICS / ITEM    | TYPE OF CHECK               | INSTRUMENT | CLASS | QUANTUM / FREQUENCY OF CHECK                   | REFERENCE DOCUMENT/ ACCETANCE STANDARD | FORMAT OF RECORD | REMARKS |

|  |                                                                  |             |        |   |      |                       |          |  |
|--|------------------------------------------------------------------|-------------|--------|---|------|-----------------------|----------|--|
|  | a. Power & control cable connections Insulation Resistance       | Visual      | Megger | A | 100% | Min 5 Mega Ohms       | Protocol |  |
|  | b. Control panel earthing Insulation resistance                  | Measurement | Megger | A | 100% | Min 5 Mega Ohms       | Protocol |  |
|  | c. Resistance box earthing                                       | Physical    |        | B |      |                       |          |  |
|  | IR value                                                         | Measurement | -      | B | 100% | Min 5 Mega Ohms       | Protocol |  |
|  | Resistance                                                       | Measurement |        | B | 100% | Drawing               | Protocol |  |
|  | d. Operation of Brakes (Hoist motion, L.T. Motion & C.T. motion) | Physical    | -      | A | 100% | O&M Manual            | Protocol |  |
|  | e. Operation of limit Switch (Hoist & traveling motion brakes)   | Physical    | -      | A | 100% | O&M Manual            | Protocol |  |
|  | f. Motors.                                                       |             | -      |   |      |                       |          |  |
|  | IR value                                                         | Measurement |        | B | 100% | Min 5 Mega Ohms       | Protocol |  |
|  | Earthing                                                         |             |        |   |      |                       |          |  |
|  | g. At no load check                                              |             |        |   |      |                       |          |  |
|  | Motor Current                                                    | Measurement | -      | A | 100% | As per procedure      | Protocol |  |
|  | Crane Speed                                                      | Measurement |        | A | 100% |                       |          |  |
|  | (only watching all motion)                                       |             |        |   |      |                       |          |  |
|  | h. At full load check / Load testing of crane (SWL):             |             |        |   |      |                       |          |  |
|  | Motor Current                                                    | Measurement |        | A | 100% | As per procedure      | Protocol |  |
|  | Crane Speed                                                      | Measurement |        | A | 100% |                       |          |  |
|  | Deflection.                                                      | Measurement |        | A | 100% |                       |          |  |
|  | i.At 25% Overload                                                |             | -      |   |      |                       |          |  |
|  | (only watching all motion)                                       | Visual      |        | A | 100% | As per procedure      | Protocol |  |
|  | j. Storm braker arrangement                                      | Physical    | -      | A | 100% | Drawing               | Protocol |  |
|  | k. Touch Up Painting.                                            | Visual      | -      | C |      | As per approved shade | Records  |  |

|                                                                                                                                                                                                                                                                                                                                            |  |                                               |                                                            |                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------|------------------------------------------------------------|---------------------------------------------------|
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**TECHNICAL SPECIFICATION**  
**FOR**  
**2x660 MW UDANGUDI TPP-STAGE I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T )**

**SECTION-I**

**REV. 00**

**DATE: MAR 2020**

**CUSTOMER SPECIFICATION**



### 2.1.0 Crane

Crane shall be provided complete with all accessories as specified under, but not limited to the following:

- a) Box type steel bridge girder complete with bridge rails, end stoppers, walkway platforms across the span of either side of crane and access ladders for double girder crane, ~~cabin for TG hall EOT crane~~, etc
- b) End carriage complete with minimum two (2) nos. of wheels for each end carriage and access ladders from gantry platforms, spring buffers etc.
- c) Service cage with all protections and access ladder, for maintenance of DSL's.
- d) Crab (trolley) with wheels and drive equipment for hoists and trolley complete with motors, gear reducers with Suitable arrangement for collection of oil spillage, brakes, limit switches, couplings, rope drums, wire ropes, main hook, auxiliary hook, end stoppers etc.
- e) Set of crane longitudinal drive equipment complete with motor, gear reducers with Suitable arrangement for collection of oil spillage, brakes, shaft bearings, gear pinions, and limit switches.
- f) EOT crane runway gantry rails complete with fixtures comprising of fixing clamps (machined to suit rail flange contour), bolts, nuts etc for effective crane longitudinal runway length, end stoppers specified.
- g) Brakes for all motion, ~~Anti-collision switch for TG hall EOT crane~~ and limit switch for over hoisting/lowering, CT and LT motion.
- h) Runway conductors & bridge cross conductors with accessories.
- i) Crane shall be operated through Pendant Push Button station. ~~TG hall EOT crane shall be operated from cabin as well as Pendant Push Button station.~~
- j) Crane buffer stops shall include the buffers on the crane itself. The stoppers to be fixed on the building frame and wheel stoppers shall be provided at either end of the crane runway.
- k) ~~Lifting beam~~, loose slings and cradle shall be provided as required.
- l) The complete electrical equipment basically including:
  - Load break changeover switch mounted on the building structure.



- Cabling between the load break switch and the down shop leads.
- Down shop leads and current collector for crane.
- Load break switch on the crane bridge walkway
- Protective and control switch gear
- Motors
- Festoon cable system for crab
- Master controllers
- Pendant controller (where specified)
- ~~Wireless remote control (where specified)~~
- Indicating lamps, push buttons.
- Lighting panel, lighting fixtures, Cabin fan, light, alarm/bell, socket outlets etc.
- All power and control cables.
- Cable trays & supports, Conduits, Cable glands, lugs & clamps etc.
- Crane earthing system
- Variable Voltage and Variable Frequency (VVVF) control for speed control of crane motors.
- ~~Electronic Anti-collision device~~

### 2.3.0 Lifting tackles

The crane installations shall be supplied with all the ropes (slings), lifting beam (if required), chains, shackles etc. needed for maintenance of the plant equipment/component.

The minimum scope of supply per handling equipment (crane & hoist) for each lifting tackle includes the following items:

- Two (2) nos. single ropes each with 2 eyes at the ends, each rope 2 m long
- Two(2) nos. single ropes each with 2 eyes at the ends, each rope 4 m long
- Four (4) nos. shackles.

The load-bearing capacity of the ropes and shackles must be suitable for the relevant crane & hoist.

The maximum tension in the rope shall not exceed 1/8 of the calculated braking capacity of the rope. The ropes shall be of the stranded type, and galvanized wires shall be used.

The eyes of the single ropes must be secured with compression fittings. The length of the eyes must be at least 15 times the nominal diameter of the rope.

In special cases, where safe lifting of the relevant component is not certain, specially-made devices shall be provided. At least two (2) of these shall be provided in each individual case.



For each installation a list shall be submitted, showing the number, type, nominal load-carrying capacity and strength characteristics of the materials used. In addition, factory and acceptance certificates shall be submitted for all ropes (slings) and materials.

### 3.0.0 DESIGN REQUIREMENTS

- a)
- b) The cranes and hoist designed to operate at 100% safe working load and subjected to over load test at 125% of rated load.
- d) Cranes and hoist shall be designed considering the ambient temperature of 50 °C.
- f) Crane and hoist control shall be from Variable Voltage and Variable Frequency (VVVF) drive. Creep speed shall be achieved through VVVF drive for cranes.
- j) The CW Pump house EOT crane shall be rated for the heaviest component to be handled in the CW Pump house.
- k) The lift for the CW Pump house EOT crane shall be based on lifting the circulating water pump out of the pump suction flume onto the maintenance floor area.
- l) Layout Considerations: The span of EOT cranes shall be derived based on the building layout with considerations to clearances and hook approach to handle all equipments.
- m) At crane girder level, Access walkway of minimum 500 mm width with safety handrails on one side shall be provided along the full span length of the cooling water building crane and other double girder cranes ~~except TG hall EOT crane.~~

#### 3.1.0 Sizing Criteria

- a) ~~The TG hall crane capacity shall be taken as 10% more than the single heaviest equipment/component to be lifted.~~ And other cranes and hoists capacity shall be selected by considering 20% margin over the weight of the component to be lifted.



- c) Auxiliary hoist shall be provided, for TG hall EOT crane and CW pump house EOT crane. AH capacity shall be rated for a minimum capacity of 20% from the main hoist capacity or 20% more than the single heaviest equipment/component to be lifted whichever is higher.
- d) For guidance purposes the following crane speeds shall be considered:-

**Double girder Cranes**

- Main Hoist      ~~1m/min (for TG hall EOT crane)~~  
2m/min (for other cranes)
- Aux Hoist      5m/min  
(if applicable)
- Trolley Travel      10 m/min
- Bridge Travel      15 m/min
- Creep speeds      10% of operating speeds for all motion

**4.0.0 DOCUMENTATION****4.1.0 Drawings, data / documents to be submitted along with bid**

- 4.1.1 Completely filled up technical schedules and data sheets of tender documents
- 4.1.2 Crane clearance diagram showing various dimensions/data. (Including highest crane hook position, safe working load etc.)
- 4.1.3 General Arrangement Drawing of the E.O.T. crane assembly.
- 4.1.4 Wheel Loading Diagram.
- 4.1.5 Detailed drawing showing the features of the components of the Crane Bridge and trolley.
- 4.1.6 A detailed write-up on the crane control system. Drawings and data sheets showing the particulars of the controllers, switches, contactors, relays, other control devices and limit switches.
- 4.1.7 General arrangement drawing of protection, control and lighting panels.
- 4.1.8 Electrical /Control Schematic diagrams.
- 4.1.9 Equipment arrangement drawing.
- 4.1.10 Quality Assurance Plan /Inspection and Test Plan (ITP).
- 4.1.11 Field Quality Plan
- 4.1.12 List of tests to be conducted at shop and at site.
- 4.1.13 Testing procedures.
- 4.1.14 A comprehensive write-up and /or brochure on the details of the manufacturing facilities and the test facilities in the shop of the supplier..
- 4.1.15 Detailed engineering, manufacturing, delivery, erection and commissioning schedule and PERT chart.
- 4.1.16 Details of similar job executed in last five years.
- 4.1.17 Lubricants list (with quantities for initial fill and make-up).
- 4.1.18 List of erection and commissioning spares for each crane.
- 4.1.19 List of recommended O&M spares for 3 years normal operation.
- 4.1.20 List of Special Tools & Tackles.
- 4.1.21 List of makes of bought out items.
- 4.1.22 End user certificates.

**4.2.0 Drawings, data / documents to be furnished by the successful bidder**

| Description |                                                      | Approval Category |
|-------------|------------------------------------------------------|-------------------|
| 4.2.1       | Technical data sheets                                | A                 |
| 4.2.2       | Crane clearance diagrams showing various dimensions. | A                 |



|        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Approval Category |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 4.2.3  | Drawings showing general arrangement, clearance requirement, assembly, cross sectional data and material of construction for :<br><br>a. E.O.T. Crane Unit<br>b. Bridge Assembly and Components<br>c. Bridge and long travel and Wheel Assembly<br>d. Trolley<br>e. Trolley Wheel Assembly<br>f. Drive and Transmission Unit for Bridge Travel, Trolley Travel, and Hoist<br>g. Suspension Unit for Hook Block<br>h. Main Hook Block<br>i. Protection, control and lighting panels.<br>j. Electric hoist<br>k. Manual hoist                                                                                                                                                                                                         | A                 |
| 4.2.4  | Drawings on runway rails, fixtures to fix runway rails with the runway main girder and stops etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | A                 |
| 4.2.5  | Design calculations of the following :<br><br>Bridge girder, Rope drum, Machinery Shafts, Gearbox excluding proprietary items, Motor rating, Brake capacity, Bearing life, Wheel loading and current collector, angle iron conductor sizing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | A                 |
| 4.2.6  | Leaflets on proprietary items such as motors, brakes, gear box, coupling etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A                 |
| 4.2.7  | Electrical documents as listed in respective sections.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | A                 |
| 4.2.8  | Material test certificates, including those for the Hooks and wire rope.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | I                 |
| 4.2.9  | Report on various tests at shop and at site and certificates of approval by authorised authority for all flame proof components and test reports for the same if required.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | I                 |
| 4.2.10 | Quality plans/ Inspection test plan and Field Quality Plan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | A                 |
| 4.2.11 | Erection Manual                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | I                 |
| 4.2.12 | Operation and Maintenance Manuals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | I                 |
| 4.3.0  | <b>To be submitted after the award of contract:</b> <ul style="list-style-type: none"><li>• Completely filled in technical Schedules.</li><li>• Dimensional General arrangement drawing for Panels, Main Switch, Master controller etc.</li><li>• Schematic wiring diagram for Panels.</li><li>• Dimensional General arrangement drawing for Motors, Brakes etc</li><li>• Characteristic curves for Motors.</li><li>• Load requirement for each crane / hoist</li><li>• VVVF Control Features.</li><li>• Control write-up for tandem operation.</li><li>• Catalogues for the all the electrical items such as cables, brakes, limit switches, relays, meters, etc.</li><li>• Quality Plans for agreed list of equipments.</li></ul> |                   |



- Type test certificates.
- Sizing calculation for DSL.
- Sizing calculation for Motors & Brakes
- Sizing calculation for Cables.
- Lighting arrangement.
- Earthing layout drawing.
- Cable routing drawing.

4.4.0 Any other drawings required for review during the detailed engineering stage, same shall also be submitted by contractor.



**VOLUME II**  
**SUB-SECTION - 2.19.1**  
**DOUBLE GIRDER EOT CRANE**

**1.0.0 CODES AND STANDARDS**

The design, manufacture, erection and testing of the crane shall conform to the latest edition of the following codes and standards along with their amendments:

|               |                                                                                                           |
|---------------|-----------------------------------------------------------------------------------------------------------|
| IS 3177       | Code of Practice for Electric Overhead Travelling Cranes and Gantry Cranes other than Steel Works Cranes. |
| IS 807        | Code of Practice for Design, Manufacture, Erection and Testing (Structural Portion) of Cranes and Hoists. |
| IS 325        | Three Phase Induction Motors.                                                                             |
| IS 2223       | Dimensions of flange mounted ac induction motors (First Revision)                                         |
| IS 1231       | Dimensions of Three-phase Foot-mounted Induction Motors (Third Revision).                                 |
| IS 2062       | Steel for General Structural Purposes.                                                                    |
| IS 2266       | Steel Wire Ropes for General Engineering Purposes.                                                        |
| IS 3443       | Crane Rail Sections.                                                                                      |
| IS 15560      | Point Hooks with Shank up to 160 Tonne specification                                                      |
| IS 5749       | Forged Ram shorn Hooks.                                                                                   |
| IS 3813/4164: | Specification for 'C' Hooks.                                                                              |

Any other International standards such as ASTM / ASME / ISO / DIN / JIS for design of coal handling system shall be followed.

**2.0.0 DESIGN CRITERIA****a) Deflections and Camber**

- i. The total maximum vertical deflections of the girders for the safe weight of working load plus the weight of the crab in central position (without taking into consideration the impact factor) shall not exceed limit of span/900 as specified by the relevant IS 807 or any other code whichever is having higher deflection shall be taken for limit.
- ii. The girder shall be cambered by an amount equal to the maximum deflection due to dead load plus one half the live load and trolley.

**b) Hooks**

Hooks shall have swivels and safety latch.



c) Hoist rope

The rope shall be of flexible plough steel with lubricated hemp (fibre) core construction. Attachment to the rope shall be provided for fastening to the drum. Rope shall be of sufficient length so that drum has two full turns when hook is at the lowest position.

d) Drums

Rope-drums shall be grooved and welded steel conforming to IS 3177. Drum shall have minimum one spare groove when this hook is at its highest position.

e) Sheaves

Rope sheaves shall be of cast steel or fabricated steel with anti-friction bearings. Sheaves shall be fully guarded to prevent rope coming off.

f) Gears

Gears shall be cut from solid cast or forged steel blanks or shall be of stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel.

Split gears shall not be used. Gears and pinions shall be totally enclosed for all motions and must be dust proof and prevent oil leakage. Gear boxes shall have oil bath type for lubrication. Gear boxes shall have covers split horizontally for inspection.

Necessary oil level indicator, Drain plugs, Lifting lugs and guards shall be provided.

g) Bearings

Bearings shall be of ball or roller type only. All anti-friction bearings shall be of approved make, which are interchangeable with corresponding size bearings of other make. Bearing housings shall be of split type or so designed to permit easy removal of the shaft. The design shall be such that there is no ingress of dust and oil or grease does not leak out. Drip pans shall be provided to accept accidental leakage and drippings. Bearings shall have minimum life expectancy of 10,000 working hours.

h) Shafts, Axles, coupling, and Keys

Shafts and axles shall be made of forged steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported. Shafts shall, as far as possible, be furnished straight. If shouldered, these shall be provided with fillets of ample radius or shall be tapered to avoid loss of strength and stress concentration. These shall be designed considering allowances for keys and splines.

All couplings shall be of steel. Flexible gear type coupling shall be provided

Keys and keyways shall conform to IS 2048 / 2291 / 2292 / 2293 as applicable.

i) Jacking pad should be provided to facilitate replacement of all bearings and wheels.

j) Sweeping plates shall be fixed to both ends of the end carriages.

k) Guard shall be provided on crane to prevent the hoist ropes coming in contact with down shop leads. Suitable guards shall be provided to revolving shafts, coupling etc.



- l) Steel made rail stops shall be provided at ends of rails for bridge and trolley welded to crane girders to prevent creeping of rails and running off of trolley. Stops shall match wheel radius for double/single girder overhead crane and buffers shall be provided as required.
- m) The span of EOT cranes shall be derived based on the final building layout with considerations to clearances and hook approach.
- n) Bridge and trolley frames shall be of fabricated structural steel sections. Mountings shall be designed to facilitate easy removal of the wheels, bearings and journals.
- o) Buffers shall be provided on trolley and bridge frames to absorb shock of impact without transferring to the frame.
- p) Crane Bridge shall be driven by two independent end drives.
- q) Wheel bases for end carriage shall not be less than 1/5 of the span or as per IS.3177
- r) The push button station shall be supported independently, earthed separately independent of suspension and shall comprise the following push buttons and indicating lamps:
  - i. 'Start' and 'Stop'
  - ii. Long travel - 'Right' and 'Left'
  - iii. Cross travel - 'To' and 'From'
  - iv. Hook - 'Hoist' and 'Lower'

Red lamp shall indicate supply 'ON'. All push buttons shall be hold-to run' type.



- t) EOT cranes conforming to Group M5 for Mechanical, Structural and M7 for Electrical of IS:3177 – 1999 shall be designed, manufactured, inspected, shop tested, erection, site testing and commissioning to well established engineering practices, safety codes and other relevant codes and standards.
- u) Safety arrangements shall be incorporated to prevent damage to motors on account of mechanical overload and electrical faults and to gearing shafts, etc. due to over stressing and other detrimental conditions.
- v) All materials / components shall be of tested quality and shall conform to the specification requirements and standards mentioned. Test certificates for MOC supplied shall be furnished for acceptance.
- w) For load carrying members the component plates, bars, angles and other rolled sections shall be minimum 8 mm thick.
- x) No cast iron part shall be used on the crane except for electrical equipment. However, in case of gear boxes casing only, use of cast iron of grade not less than 25, IS: 210 -1962 is recommended. Similarly, no wood or other combustible material shall be used in any part of the crane.
- y) Parts requiring replacement or lubrication shall easily be accessible without dismantling the other equipment and structures.
- z) Defects in the material like fractures, cracks, blow holes, pitting etc. are not allowed. Rectification /Replacement of any such flow are permissible only with the approval of the owner.
- aa) Overload protection system must be considered for the Hoist with additional operational limit switches.
- bb) Crane shall be complete with trolley, tracks, wheels, axles, drive mechanism, hoisting drum brakes, horns, warning, lights, limit switches etc.
- cc) Ladders shall be provided for accessing the walkway from operating floor on both sides of the building. Minimum 500 mm clear walkway shall be provided along the building columns on both sides of TG building (Full length) and one side of full length all double girder cranes.
- dd) Access ladder shall be provided for access the crane from building walkway. And ladder shall be provided for access the cabin & maintenance cage from crane walkway.
- ee) Platforms / walkways in crane shall be provided for maintenance with 750 mm clear inside width. Non skid steel plate of thickness 6 mm with toe guards of 100 mm height above the floor level and safety hand railing shall be provided along the full span length on either side of the crane bridge girders. The hand railings shall consist of 32 mm NB pipe in two (2) tiers. Top pipe shall be at about one (1) m and middle pipe shall be at about 450 mm height from the walkway platform level.



- ff) Two individual bridge girders in plate welded box type are fabricated from tested steel plates. Box section shall be adequately reinforced by internal diaphragms and ribs.
- gg) The brakes shall be located on input shaft / extension of input shaft of gear reducer. Coupling halves shall not be used as brake drums.
- hh) Anti-collision switch shall be provided wherever applicable.

### 3.0.0 ELECTRICAL REQUIREMENTS

- a) Electrical equipment shall be adequately rated to permit simultaneous operation of any combination of motions of the crane for its duty service.
- b) Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.
- c) Motors shall suit the duty class S4, cyclic duration factor 60% and 300 starts per hour and shall be suitable for VVF operation. Motor pull out torque shall not be less than 2.75 times/ rated torque. Motor shall have class F insulation temperature rise limited to class B and enclosures shall conform to the degree of protection IP-55.
- d) All motors shall be capable of the following :
  - Operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.
  - Withstand 120% of rated speed for two minutes.
  - Current shall not exceed 6 times full load current for creep speed motor.
  - Withstanding the stresses imposed if started at 110% rated voltage.
  - Start with rated load and accelerate to full speed with 80% rated voltage at motor terminals.
  - The locked rotor motor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 3 seconds for motors upto 20 seconds starting time.
  - Maximum torque shall not be below 200% of full load torque.
- e) Each motor more than 30 KW rating shall be provided with space heater. All electrical equipment accessories and wiring shall have tropical protection.
- f) The crane(s) shall be furnished complete with all electrical equipment, accessories, like drive motors with VVF drives, conductors, insulators, protective & operating devices, cables, current collectors, all protective devices, anti collision limit switches, mechanical overload and protection for electrical faults etc.
- g) The limit switches shall be totally enclosed type IP-55.
- h) Each hoist shall be furnished with two (2) limit switches meeting the following requirements:
  - A screw type limit switch with self resetting features which will act in case of over hoisting.
  - A gravity operated hand reset type limit switch as a back up protection against over hoisting.
- i) Track type limit switches shall be provided on the bridge and trolley to prevent over travelling in either direction.
- j) Trailing cable shall be 1100 V grade, tinned copper, heat resistant, with EPR insulation and as per Class – 5 of IS-8130. Also should have inner PCP sheath and outer CSP sheath with nylon chord reinforcement & heat resistant, oil resistant and flame retardant heavy duty FRLS type.



- k) Necessary start/stop and emergency controls shall be provided. Automatic reset type limit switches shall be provided to prevent over-travel for:

- Over hoisting and lowering motions of the hook.
- Long travel motion
- Cross travel motion

- l) Down Shop Leads (DSL)

One (1) set of shrouded type down shop leads (DSL) with copper conductor for the crane runway length shall be provided. Conductor shall be colour coded for R, Y, B phases and ground. Current carrying capacity of Runway conductors shall be designed for simultaneous operation of the two cranes as applicable.

The shrouded copper bus bar conductor system shall comprise of 4 wire suitable for single power feed to mid point. The material of shroud shall be PVC suitable for 70 deg. C. The continuous current rating of the conductors shall be so chosen that the voltage drop from load break switch to the motor terminal is restricted to 3 % based on maximum derated current and 10% based on peak current. Minimum 20% allowance for wear and tear shall be provided over the calculated size.

- m) VVVF control

The VVF drive control shall be used for control of each motion. The VVF drive shall be equipped at least with 1024 pulse in card, droop control for synchronization and crane software. The rating of VVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.

VVVF system shall be rated for continuous duty as per IEC 146 (clause II). Output frequency range shall be minimum 0 to 50 Hz at constant torque and 0 to 100 Hz at constant power. Efficiency of VVVF shall be minimum 97%.

Individual converters shall be provided for each vector drive. The harmonic content reflected on incoming line is to be limited to 5% THD and 3% for individual harmonics. Harmonics filters preferably along with 12 pulse converter/IGBT based converter shall be used to achieve this.



## ANNEX 2.19.1

## SPECIFIED DESIGN DATA – DOUBLE GIRDER EOT CRANE

| Sl.No. | Description                                                                    | Data                                                                                                                                                                                                    |            |                                                                 |             |
|--------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------------------------------------------------|-------------|
| 1      | Design, fabrication and testing of the crane conform to standard / code number | As per IS : 3177 – 1999 / IS:807                                                                                                                                                                        |            |                                                                 |             |
| 2      | Operation                                                                      | Wireless remote control & Pendent push button for all double girder cranes.<br><del>Wireless remote control + Operator cabin + pendent push button for TG hall EOT crane</del>                          |            |                                                                 |             |
| 3      | Crane Components                                                               |                                                                                                                                                                                                         |            |                                                                 |             |
| 3.1    | Type of girder                                                                 | Double girder box type                                                                                                                                                                                  |            |                                                                 |             |
| 3.2    | Type of connection to end carriage                                             | By fitted bolts                                                                                                                                                                                         |            |                                                                 |             |
| 3.3    | Girder material                                                                | IS2062 Gr. A/B                                                                                                                                                                                          |            |                                                                 |             |
| 4      | Rails-Bridge Girder                                                            |                                                                                                                                                                                                         |            |                                                                 |             |
| 4.1    | Type / section                                                                 | Rails sections as per IS: 3443 Grade 50 C 12. Joint to be butt-welded by thermit welding & fusion welding or by end clamping welded by thermit welding & Fusion welding or by end clamping arrangement. |            |                                                                 |             |
| 4.2    | Material                                                                       | Rail Steel                                                                                                                                                                                              |            |                                                                 |             |
| 5      | Lifting hooks                                                                  | MH                                                                                                                                                                                                      |            | AH (if applicable)                                              |             |
| 5.1    | Type                                                                           | Ram shorn for more than 50T or 'C' type swiveling hook with locking device.                                                                                                                             |            | 'C' type swiveling hook with locking device.                    |             |
| 5.2    | Material                                                                       | EN 3A-BS 970 Class 2 IS:1875                                                                                                                                                                            |            |                                                                 |             |
| 5.3    | Standard conforming to                                                         | Ram shorn: IS:5749<br>Single hook (or) “C” hook: IS 15560                                                                                                                                               |            |                                                                 |             |
| 6      | Trolley                                                                        |                                                                                                                                                                                                         |            |                                                                 |             |
| 6.1    | Type                                                                           | Fabricated                                                                                                                                                                                              |            |                                                                 |             |
| 6.2    | Method of fabrication                                                          | Fusion welded                                                                                                                                                                                           |            |                                                                 |             |
| 6.3    | Material conforming to IS:                                                     | IS: 2062 Gr. A or B                                                                                                                                                                                     |            |                                                                 |             |
| 6.4    | Number of Trolleys                                                             | One (1) per crane                                                                                                                                                                                       |            |                                                                 |             |
| 6.5    | Number of hoists on trolley                                                    | One (1) Main + One (1) auxiliary hoist (if applicable).                                                                                                                                                 |            |                                                                 |             |
| 7      | Sheaves details                                                                | Main hoist                                                                                                                                                                                              |            | Aux. hoist                                                      |             |
| 7.1    | Material                                                                       | Fe 410 WA IS: 2062 Gr. A or B /<br>CS Gr. 280-520 IS:1030<br>Design as per IS:3177-1999                                                                                                                 |            |                                                                 |             |
| 7.2    | Diameter of equivalent sheaves in mm on root                                   | Should not be less than 62% of calculated main sheave diameter                                                                                                                                          |            | Should not be less than 62% of calculated main sheave diameter. |             |
| 7.3    | Type of guards provided                                                        | Fabricated from sheet steel                                                                                                                                                                             |            |                                                                 |             |
| 8      | Coupling & shafting                                                            |                                                                                                                                                                                                         |            |                                                                 |             |
| 8.1    | Coupling details (between motor and gear box)                                  | Main hoist                                                                                                                                                                                              | Aux. hoist | Cross travel                                                    | Long travel |
| a)     | Type                                                                           | Flexible geared type                                                                                                                                                                                    |            |                                                                 |             |



| Sl.No. | Description                                              | Data                                                                                                                          |  |                       |  |
|--------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--|-----------------------|--|
| b)     | Guards and Enclosures                                    | Provided                                                                                                                      |  |                       |  |
| 8.2    | Coupling details (gear box and wheels)                   | Cross travel                                                                                                                  |  | Long travel           |  |
| a)     | Type                                                     | Flexible geared type                                                                                                          |  |                       |  |
| b)     | Guards and Enclosures                                    | Provided                                                                                                                      |  |                       |  |
| 8.3    | Coupling details (gear box and rope drum)                | Main hoist                                                                                                                    |  | Aux. hoist            |  |
| a)     | Type                                                     | Flexible geared type                                                                                                          |  |                       |  |
| b)     | Guards and Enclosures                                    | Provided                                                                                                                      |  |                       |  |
| 8.4    | Shafting (output)                                        |                                                                                                                               |  |                       |  |
| a)     | Factor of safety                                         | As per IS:3177-1999                                                                                                           |  |                       |  |
| b)     | Arrangement of lubrication                               | Grease cups / Nipples                                                                                                         |  |                       |  |
| c)     | Type of lubricant                                        | Grease                                                                                                                        |  |                       |  |
| 9      | Gear box details                                         |                                                                                                                               |  |                       |  |
| 9.1    | Hoist Motions                                            | MH                                                                                                                            |  | AH                    |  |
| a)     | Type of mounting of gear box                             | Horizontal / Vertical                                                                                                         |  |                       |  |
| b)     | Classification                                           | Suitable for M5 duty                                                                                                          |  |                       |  |
| c)     | Type of gears                                            | Helical / Spur                                                                                                                |  | Helical / Spur        |  |
| d)     | Type of lubrication (grease / splash / pump lubrication) | Splash lubrication                                                                                                            |  |                       |  |
| e)     | Difference in gear and pinion hardness                   | Min 20 BHN                                                                                                                    |  |                       |  |
| f)     | Materials (gear / pinions)                               | Main Gears En 9/55C8/IS2707 Gr. 1 or 2<br>Pinions En 19/EN 24<br>Hardness conforming to IS:3177                               |  |                       |  |
| g)     | Casings                                                  | Fabricated Fe 410w IS:2062 Gr A/B & stress relieved                                                                           |  |                       |  |
| 9.2    | Travel Motions                                           | CT                                                                                                                            |  | LT                    |  |
| a)     | Type of mounting gear box                                | Vertical                                                                                                                      |  | Vertical / Horizontal |  |
| b)     | Classification                                           | M5 duty                                                                                                                       |  |                       |  |
| c)     | Type of gears                                            | Helical / Spur                                                                                                                |  | Helical / Spur        |  |
| d)     | Type of lubrication (Grease / splash / pump lubrication) | Splash lubrication                                                                                                            |  |                       |  |
| e)     | Difference in gear and pinion hardness                   | Min 20 BHN                                                                                                                    |  |                       |  |
| f)     | Materials (gear / pinions)                               | Main Gears En 9/55C8/IS 2707 Gr. 1 or 2<br>Pinions En 19/ EN 24.<br>Hardness conforming to IS:3177                            |  |                       |  |
| g)     | Casings                                                  | Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved.                                                                         |  |                       |  |
| 10     | Warning gong                                             | Operated from pendant. Suitable for 240V AC of noise level 95 dBA at 3.5 m                                                    |  |                       |  |
| 11     | Rope Drum                                                |                                                                                                                               |  |                       |  |
| 11.1   | Type                                                     | Rope drums shall be spur / helical gear type and should be fabricated from M.S. as per IS 2062 and should be stress relieved. |  |                       |  |
| 11.2   | Rope drums                                               | Main hoist                                                                                                                    |  | Aux. Hoist            |  |
| a)     | Material (Indicate IS)                                   | Seamless pipe ASTM-106 or fabricated Fe410w IS: 2062 Gr. A/B & stress relieved.                                               |  |                       |  |
| b)     | Numbers provided                                         | One for each hoist                                                                                                            |  |                       |  |
| c)     | Type of grooves                                          | Identical right hand and left hand                                                                                            |  |                       |  |
| d)     | Flange / flangeless                                      | Flanged                                                                                                                       |  |                       |  |



| Sl.No. | Description                | Data                                                                                                                                                   |                              |             |            |
|--------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------|------------|
| 12     | Wire Rope                  |                                                                                                                                                        |                              |             |            |
| 12.1   | Rope details               | Extra flexible plough steel conforming to IS:2266, Rope grade 1770                                                                                     |                              |             |            |
| 12.2   | Construction               | 6 x 36                                                                                                                                                 |                              |             |            |
| 12.3   | Factor of safety           | Not less than 5.25 / As per IS                                                                                                                         |                              |             |            |
| 12.4   | Type of core               | Fibre                                                                                                                                                  |                              |             |            |
| 13     | Wheels                     |                                                                                                                                                        |                              |             |            |
| 13.1   | Wheels                     | Cross travel                                                                                                                                           | long travel                  |             |            |
| 13.2   | Type                       | Double flanged                                                                                                                                         |                              |             |            |
| 13.3   | Materials                  | Forged Steel / C 55 Mn 75                                                                                                                              |                              |             |            |
| 13.4   | Hardness                   | 300-350 BHN.                                                                                                                                           |                              |             |            |
| 13.5   | Arrangement of lubrication | Grease                                                                                                                                                 |                              |             |            |
| 13.6   | Bearing for the wheels     | Antifriction Bearings.                                                                                                                                 |                              |             |            |
| 13.7   | Method of lubrication      | Grease lubrication                                                                                                                                     |                              |             |            |
| 13.8   | Bearing life               | 10,000 working hours                                                                                                                                   |                              |             |            |
| 14     | Limit Switches             |                                                                                                                                                        |                              |             |            |
|        | Type<br><br>Quantity       | Main Hoist:                                                                                                                                            | Aux, Hoist (If applicable)   | CT          | LT         |
|        |                            | Rotary geared + gravity type                                                                                                                           | Rotary geared + gravity type | lever type  | lever type |
|        |                            | 1+1                                                                                                                                                    | 1+1                          | 2*          | 2          |
| 14.1   | Protection                 | Based on the location.                                                                                                                                 |                              |             |            |
| 15     | Brakes                     | Main Hoist:                                                                                                                                            | Aux, Hoist                   | CT          | LT         |
| 15.1   | Type                       | AC Electro Hydraulic Thruster operated + DC Electro Magnetic disc                                                                                      |                              |             |            |
| 15.2   | Quantity                   | 1+ 1                                                                                                                                                   | 1+ 1                         | 1+1         | 1+1        |
| 15.3   | Braking capacity           | 150%                                                                                                                                                   | 150%                         | 125%        | 125%       |
| 16     | Buffer                     | Cross Travel                                                                                                                                           |                              | Long Travel |            |
| 16.1   | Number                     | 4                                                                                                                                                      |                              | 4           |            |
| 16.2   | Type                       | Rubber / Spring loaded type. To be designed to bring the loaded crane to rest from speed of 50% of the rated speed.                                    |                              |             |            |
| 17     | Electrical                 |                                                                                                                                                        |                              |             |            |
| 17.1   | Power supply               | Shrouded type down shop leads (copper) shall be provided to supply power to crane. Power supply to Crab shall be through flexible trailing conductors. |                              |             |            |
| 17.2   | Rating                     | S4, 60% CDF                                                                                                                                            |                              |             |            |
| 17.3   | Number of starts / hour    | 300 starts / hr                                                                                                                                        |                              |             |            |

Note: 1. ~~Tandem operation will not be envisaged for the TG hall EOT cranes.~~

2. \* Two number of one way lever type' limit switches or one no. two way lever type limit switch shall be provided for each CT & LT motion

**21.0.0 TRAINING REQUIREMENTS****21.1.0 Training requirements****21.1.1 General**

The Contractor shall be responsible for the instruction and training of the Owner's operation and maintenance personnel and his O & M contractor in all aspects of plant design, construction, erection, commissioning, etc. and in such a way that operation, maintenance and if necessary repairs of all the power project equipment and facilities specified can be handled competently by said personnel. The cost of travel expenses including travel insurance, boarding and lodging expenses of the training have to be borne by the EPC contractor. Daily allowance shall not be borne by the EPC contractor. This includes training in India and foreign countries.

Such training of the Owner's personnel shall be performed

- In Contractor's and/or sub supplier's/manufacturer's home office and/or workshops.
- In similar power projects and such power projects which are under erection and commissioning as well as at the proposed similar Power Project by using the training simulator.
- On the job site by the Contractor's and/or his sub-suppliers, supervisors and/or instructors deputed to the site for supervision of erection, commissioning, testing and trial operation and/or by specialized training instructors;
- At the Power Project by the supervisors deputed to the Plant during the Warranty Period;

In compliance with the provisions of the Contract and the requirements of this specification.

The personnel required for the safe and efficient plant commercial operation and maintenance of the various types of equipment installed shall be provided by the Owner in accordance with the recommendation to be made by the Contractor.

The training will be performed in English. Translators/interpreters shall be provided by the Contractor.

The Contractor's instructors shall use modern training techniques, procedures and aids and make available to the trainees all required notes, manuals, drawings, etc., to supplement the Operation and Maintenance Instruction Manuals.

The Contractor shall provide a detailed description about the recommended training services, including

- Number, category, seniority, required experience, profile required, etc. of the trainees
- Preliminary training program, showing
  - Training facilities, training aids places of training etc.
  - Training schedule
  - Specialty and details of lectures and training
  - Duration of training courses

for all kind of training activities, abroad, classroom, on the job site, at the proposed Power Project, etc.

The recommended training program should be based on the organizational and staff structures of coal fired power projects already in operation in India and should take into consideration not only the training for operation and maintenance staff, such as operators, skilled workers, foremen and technicians etc, but also for senior staff and key personnel employed for the management and organizational duties of the various power project



decisions, such as for operation, maintenance, instrumentation and control, chemistry, administration, security, spare parts handling, scheduling and engineering, etc.

An indicative training programme is proposed below which will be firmed up during contract stage:

| Group                                         | Number of man-month |
|-----------------------------------------------|---------------------|
| Overall Plant Management                      | 18                  |
| Operation Team                                | 45                  |
| Mechanical Maintenance Personnel              | 30                  |
| Electrical Maintenance Personnel              | 15                  |
| C&I Engineers                                 | 15                  |
| Other groups as may be indicated by the Owner | 9                   |

The training programme includes all the aspects of training and the duration as per Annex 1.5.

The above training programme shall include training of 44 persons on 2 months Site training and 1 month training at manufacturer's works. Bidder shall indicate in his offer, the break-up of number of man-months of training overseas and in India meeting the above training programme.

#### 21.2.0 Contractor's Obligations and Tasks

The Contractor shall make every effort to train the Owner's personnel and his authorized O & M contractors so that they can be qualified for the management, operation and maintenance of the Contract Plant

The Contractor shall nominate a person in charge of organization and co-ordination activities for training.

The Contractor shall select instructors with proper experience and skillfulness and English speaking capability to train the Owner's personnel.

The training program will be carried out according to the requirements of each specialty. It will consist mainly of but not limited to the following:

- Systematic explanation in a classroom of specific subjects, such as the equipment performance, construction, main systems, auxiliary systems, etc.;
- Visit to power plants;
- Practical training in similar power projects which are under erection and commissioning.
- Practical training on simulators and control rooms of similar power projects.
- Supply of all necessary training documentation ( such as books, manuals, drawings), equipment, tools and instruments etc. The Contractor will make best effort to achieve above item (c) and (d) with utility authority.

The Contractor will make available free of charge to the Owner's personnel working cloths, safety helmets, stationery etc. as needed by the training program.



The Contractor shall allow the Owner's personnel to carry back all the technical documents supplied during the training.

The Contractor shall make at the end of the training period an evaluation of the results obtained by each trainee. These results will be confidentially notified to the Owner.

The Contractor shall assist the Owner's personnel in arranging their entry visas and all the formalities staying in foreign countries for training. The Contractor shall also take all the necessary measures to ensure the safety of the Owner's personnel during their stay in the foreign country.

The Contractor shall appoint a person in charge of logistic coordination. This person shall take care for booking of rooms according to the requirements of the Owner and arranging for transportation (free of charge) from their living place to the training site. The cost of travel expenses including travel expenses, boarding and lodging expenses of the training have to be borne by the EPC contractor. Daily allowance shall not be borne by the EPC contractor

The Contractor shall provide free medical services to the Owner's personnel during their stay in the foreign country.

### **21.3.0 Owner's Responsibilities**

The Owner shall appoint a person as official representative of the Owner's trainees.

The trainees shall understand the English language and shall follow the training courses with due diligence. During their stay abroad the Owner's personnel shall observe the Laws of that country and the rules/regulations of the factories/plants where the training will be conducted. The official holidays or national holidays, Saturdays and Sundays shall be the holidays of the Owner's personnel.

For the successful completion of the training program, unless mutually agreed by the parties, the program cannot be interrupted for vacation leave.

The cost of travel expenses, boarding and lodging expenses of the training/inspection have to be borne by the EPC contractor.

### **21.4.0 Training schedule and program**

The Training program for the Owner's personnel will be defined during the liaison meeting.

Two (2) months before the arrival of the first group of the Owner's personnel in training site, the Owner shall inform the Contractor of the date when the Owner's personnel are expected to be sent to training site

Within 2 (two) weeks after receipt of the Owner's information mentioned above, the Contractor shall confirm its agreement or indicate difficulties, if any, for the staying of the personnel. Thirty (30) days before the arrival of the Owner's personnel in the training site the Owner shall inform the Contractor of the brief career of the personnel including names, date of birth, nationality, specialty, experience, qualification, position and knowledge of foreign languages, passport details etc., so that the Contractor can assist in arranging their entry visas.

The Contractor shall not charge the Owner with the costs for the training activities in the respective training sites.

In case the Owner fails to send his personnel to attend the above training, the Contractor shall reimburse the relevant amount to the Owner



**TECHNICAL SPECIFICATION**  
**FOR**  
**2x660 MW UDANGUDI TPP-STAGE I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T)**

**SECTION-I**

**SUB-SECTION-IA**

**REV. 00**

**DATE: MAR 2020**

## **ANNEXURES**



**TECHNICAL SPECIFICATION  
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**ANNEXURE-I  
MAKES OF SUB-VENDOR ITEMS**

| SR. NO. | ITEM           | SUPPLIERS                              | PLACE   | REMARKS              |
|---------|----------------|----------------------------------------|---------|----------------------|
| 1.      | STEEL          | SAIL                                   |         |                      |
|         |                | TISCO                                  |         |                      |
|         |                | JINDAL                                 |         |                      |
|         |                | ESSAR                                  |         |                      |
| 2.      | HOOKS          | STEEL FORGING & ENGG. CO.,             | KOLKATA |                      |
|         |                | SIMRITI FORGING                        |         |                      |
|         |                | KARACHIWALA                            |         | UP TO 25T CAPACITY   |
| 3.      | GEAR COUPLINGS | ALLIANCE                               |         |                      |
|         |                | FLEX-TRANS (formerly known as HICLIFF) |         |                      |
|         |                | SAHARA                                 |         |                      |
|         |                | NUTECH                                 |         |                      |
|         |                | OEM                                    |         |                      |
| 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                                    |         |                      |
| 7.      | BRAKES         | ELECTROMAG                             |         |                      |
|         |                | SPEED-O- CONTROL                       |         |                      |
|         |                | BCH                                    |         | FOR DCEM BRAKES ONLY |
|         |                | KAKKU                                  |         |                      |
|         |                | PATHE                                  |         |                      |
| 8.      | CONTACTOR      | SIEMENS                                |         |                      |
|         |                | L&T                                    |         |                      |
|         |                | SCHNEIDER (Earlier TELE MECHANIQUE)    |         |                      |



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**SUB-SECTION-IA**

**REV. 00**

**DATE: MAR 2020**

| SR. NO. | ITEM                              | SUPPLIERS                            | PLACE   | REMARKS |
|---------|-----------------------------------|--------------------------------------|---------|---------|
|         |                                   | 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.     | BULB & FLOURESCENT TUBES/FITTINGS | PHILIPS                              |         |         |
|         |                                   | BAJAJ                                |         |         |
|         |                                   | CROMPTON                             |         |         |
| 16.     | CABLE LUGS (HEAVY DUTY)           | DOWELLS                              |         |         |
|         |                                   | UML ENGINEERS                        | KOLKATA |         |
|         |                                   | JAINSON                              |         |         |
| 17.     | HOOTERS                           | BEACON                               |         |         |



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**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T)**

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|---------|--------------------|--------------------------------------------|-------------------|---------|
|         |                    | OSC                                        |                   |         |
|         |                    | TARGET                                     |                   |         |
|         |                    | KHERAJ                                     |                   |         |
| 18.     | LIGHTING SWITCHES  | ANCHOR                                     |                   |         |
|         |                    | ELLORA                                     |                   |         |
|         |                    | BAJAJ                                      |                   |         |
|         |                    | PHILIPS                                    |                   |         |
| 19.     | PVC POWER CABLES   | APAR INDUSTRIES LTD.                       | MUMBAI            |         |
|         |                    | CORDS CABLE INDUSTRIES LTD.                | NEW DELHI         |         |
|         |                    | DIAMOND POWER INFRASTRUCTURE LTD           | VADODARA          |         |
|         |                    | GOYOLENE FIBRES (INDIA) PVT.LTD            | MUMBAI            |         |
|         |                    | GOVIND CABLE INDUSTRIES                    | KOLKATA           |         |
|         |                    | GUPTA POWER INFRASTRUCTURE LIMITED         | BHUBNESWAR        |         |
|         |                    | HAVELLS INDIA LIMITED                      | NOIDA             |         |
|         |                    | KEI INDUSTRIES LTD.                        | NEW DELHI         |         |
|         |                    | KRISHNA ELECTRICAL INDUSTRIES LTD          | GWALIOR           |         |
|         |                    | KEC INTERNATIONAL LIMITED                  | MUMBAI            |         |
|         |                    | MANSFIELD CABLES COMPANY LTD.              | NOIDA             |         |
|         |                    | NICCO CORPORATION LTD.                     | KOLKATA           |         |
|         |                    | PARAMOUNT COMMUNICATIONS LTD.              | NEW DELHI         |         |
|         |                    | POLYCAB WIRES PVT. LTD.                    | MUMBAI            |         |
|         |                    | RADIANT CORPORATION PRIVATE LIMITED        | HYDERABAD         |         |
|         |                    | RAVIN CABLES LIMITED                       | MUMBAI            |         |
|         |                    | SUYOG ELECTRICALS LTD.                     | VADODARA          |         |
|         |                    | SRIRAM CABLES PVT. LTD.                    | NEW DELHI         |         |
|         |                    | SCOT INNOVATION WIRES AND CABLES PVT. LTD. | SOLAN             |         |
|         |                    | SAM CABLES & CONDUCTORS (P) LTD            | UDHAM SINGH NAGAR |         |
|         |                    | THERMO CABLES LTD                          | HYDERABAD         |         |
| 20.     | PVC CONTROL CABLES | ADVANCE CABLE TECHNOLOGIES (P) LTD         | BANGALORE         |         |
|         |                    | APAR INDUSTRIES LTD., CMI LTD              | MUMBAI            |         |
|         |                    | CMI LIMITED                                | FARIDABAD         |         |



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|------------|------------------------|----------------------------------------------|----------------------|---------|
|            |                        | CORDS CABLE INDUSTRIES LTD                   | NEW DELHI            |         |
|            |                        | CRYSTAL CABLE INDUSTRIES LTD                 | KOLKATA              |         |
|            |                        | DELTON CABLES LTD                            | NEW DELHI            |         |
|            |                        | DIAMOND POWER<br>INFRASTRUCTURE LTD          | VADODARA             |         |
|            |                        | ELKAY TELELINKS LTD                          | NEW DELHI            |         |
|            |                        | GEMSCAB INDUSTRIES LTD                       | NEW DELHI            |         |
|            |                        | GOVIND CABLE INDUSTRIES                      | KOLKATA              |         |
|            |                        | GUPTA POWER<br>INFRASTRUCTURE LIMITED        | BHUBNESWAR           |         |
|            |                        | HAVELLS INDIA LIMITED                        | NOIDA                |         |
|            |                        | INCOM CABLES (P) LTD                         | NEW DELHI            |         |
|            |                        | KEI INDUSTRIES LTD                           | NEW DELHI            |         |
|            |                        | KRISHNA ELECTRICAL INDUSTRIES<br>LTD         | GWALIOR              |         |
|            |                        | KEC INTERNATIONAL LIMITED                    | MUMBAI               |         |
|            |                        | MANSFIELD CABLES COMPANY<br>LTD              | NOIDA                |         |
|            |                        | NICCO CORPORATION LTD                        | KOLKATA              |         |
|            |                        | PARAMOUNT<br>COMMUNICATIONS LTD              | NEW DELHI            |         |
|            |                        | POLYCAB WIRES PVT. LTD                       | MUMBAI               |         |
|            |                        | RAVIN CABLES LIMITED                         | MUMBAI               |         |
|            |                        | SUYOG ELECTRICALS LTD                        | VADODARA             |         |
|            |                        | SPECIAL CABLES PVT. LTD                      | NEW DELHI            |         |
|            |                        | SCOT INNOVATION WIRES AND<br>CABLES PVT. LTD | SOLAN                |         |
|            |                        | SAM CABLES & CONDUCTORS (P)<br>LTD           | UDHAM SINGH<br>NAGAR |         |
|            |                        | SPM POWER & TELECOM PVT.<br>LTD              | HYDERABAD            |         |
|            |                        | TORRENT CABLES LTD                           | AHMEDABAD            |         |
|            |                        | THERMO CABLES LTD                            | HYDERABAD            |         |
|            |                        | TIRUPATI PLASTOMATICS PVT.<br>LTD            | JAIPUR               |         |
|            |                        | UNIVERSAL CABLES LTD                         | SATNA                |         |
| <b>21.</b> | <b>TRAILING CABLES</b> | NICCO                                        | KOLKATA              |         |
|            |                        | UNIVERSAL                                    | SATNA                |         |
|            |                        | INCAB                                        |                      |         |
|            |                        | ICL                                          | NEW DELHI            |         |
|            |                        | APAR INDUSTRIES LTD                          | MUMBAI               |         |



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|---------|---------------------|-------------------------------------------|------------|---------|
|         |                     | CMI LTD                                   | FARIDABAD  |         |
|         |                     | KEI INDUSTRIES LTD                        | NEW DELHI  |         |
|         |                     | SUYOG ELECTRICALS LTD                     | VADODARA   |         |
| 22.     | XLPE POWER CABLES   | APAR INDUSTRIES LTD                       | MUMBAI     |         |
|         |                     | CORDS CABLE INDUSTRIES LTD                | NEW DELHI  |         |
|         |                     | CRYSTAL CABLE INDUSTRIES LTD              | KOLKATA    |         |
|         |                     | DIAMOND POWER INFRASTRUCTURE LTD          | VADODARA   |         |
|         |                     | GEMSCAB INDUSTRIES LTD                    | NEW DELHI  |         |
|         |                     | GOVIND CABLE INDUSTRIES                   | KOLKATA    |         |
|         |                     | GUPTA POWER INFRASTRUCTURE LIMITED        | BHUBNESWAR |         |
|         |                     | HAVELLS INDIA LIMITED                     | NOIDA      |         |
|         |                     | KEI INDUSTRIES LTD                        | NEW DELHI  |         |
|         |                     | KRISHNA ELECTRICAL INDUSTRIES LTD         | GWALIOR    |         |
|         |                     | KEC INTERNATIONAL LIMITED                 | MUMBAI     |         |
|         |                     | MANSFIELD CABLES COMPANY LTD              | NOIDA      |         |
|         |                     | PARAMOUNT COMMUNICATIONS LTD              | NEW DELHI  |         |
|         |                     | POLYCAB WIRES PVT. LTD                    | MUMBAI     |         |
|         |                     | RAVIN CABLES LIMITED                      | MUMBAI     |         |
|         |                     | SUYOG ELECTRICALS LTD                     | VADODARA   |         |
|         |                     | SPECIAL CABLES PVT. LTD                   | NEW DELHI  |         |
|         |                     | SCOT INNOVATION WIRES AND CABLES PVT. LTD | SOLAN      |         |
|         |                     | SRIRAM CABLES PVT. LTD                    | NEW DELHI  |         |
|         |                     | TORRENT CABLES LTD                        | AHMEDABAD  |         |
|         |                     | THERMO CABLES LTD                         | HYDERABAD  |         |
|         |                     | TIRUPATI PLASTOMATICS PVT. LTD            | JAIPUR     |         |
| 23.     | XLPE CONTROL CABLES | APAR INDUSTRIES LTD                       | MUMBAI     |         |
|         |                     | CABLE CORPORATION OF INDIA LTD            | MUMBAI     |         |
|         |                     | CRYSTAL CABLE INDUSTRIES LTD              | KOLKATA    |         |
|         |                     | DIAMOND POWER INFRASTRUCTURE LTD          | VADODARA   |         |
|         |                     | GEMSCAB INDUSTRIES LTD                    | NEW DELHI  |         |
|         |                     | HAVELLS INDIA LIMITED                     | NOIDA      |         |
|         |                     | KEI INDUSTRIES LTD                        | NEW DELHI  |         |
|         |                     | KRISHNA ELECTRICAL INDUSTRIES             | GWALIOR    |         |



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| SR. NO. | ITEM                        | SUPPLIERS                           | PLACE     | REMARKS |
|---------|-----------------------------|-------------------------------------|-----------|---------|
|         |                             | LTD                                 |           |         |
|         |                             | KEC INTERNATIONAL LIMITED           | MUMBAI    |         |
|         |                             | PARAMOUNT COMMUNICATIONS LTD        | NEW DELHI |         |
|         |                             | POLYCAB WIRES PVT. LTD              | MUMBAI    |         |
|         |                             | RADIANT CORPORATION PRIVATE LIMITED | HYDERABAD |         |
|         |                             | RAVIN CABLES LIMITED                | MUMBAI    |         |
|         |                             | SUYOG ELECTRICALS LTD               | VADODARA  |         |
|         |                             | SRIRAM CABLES PVT. LTD              | NEW DELHI |         |
|         |                             | TORRENT CABLES LTD                  | AHMEDABAD |         |
|         |                             | UNIVERSAL CABLES LTD                | SATNA     |         |
| 24.     | CABLE GLAND                 | COMMET                              |           |         |
|         |                             | SUNIL&CO                            |           |         |
|         |                             | ARUP ENGINEERING                    |           |         |
|         |                             | JAINSON                             |           |         |
|         |                             | DOWELL                              |           |         |
| 25.     | PUSH BUTTONS                | SIEMENS                             |           |         |
|         |                             | L&T                                 |           |         |
|         |                             | BCH                                 |           |         |
|         |                             | SCHNEIDER                           |           |         |
| 26.     | LIMIT SWITCHES              | SPEED-O-CONTROL                     |           |         |
|         |                             | ELECTROMAG                          |           |         |
| 27.     | MASTER CONTROLLER           | SPEED-O-CONTROL                     |           |         |
|         |                             | ELECTROMAG                          |           |         |
| 28.     | SAFETY SWITCHES             | ALSTOM                              |           |         |
|         |                             | L&T                                 |           |         |
|         |                             | SIEMENS                             |           |         |
| 29.     | PENDENT PUSH BUTTON STATION | OEM                                 |           |         |
| 30.     | INDICATING LAMPS            | TECKNIC                             |           |         |
|         |                             | BCH                                 |           |         |
|         |                             | SIEMENS                             |           |         |
|         |                             |                                     |           |         |
|         |                             | STANDARD                            |           |         |
| 31.     | MCB                         | MDS                                 |           |         |
|         |                             | INDO COPP                           |           |         |
|         |                             | STANDARD                            |           |         |
|         |                             | SIEMENS                             |           |         |



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|---------|-----------------------|--------------------------------------|-------|---------------------------------------|
|         |                       | L&T                                  |       |                                       |
|         |                       | ABB                                  |       |                                       |
|         |                       | SCHNEIDER                            |       |                                       |
| 32.     | PANELS                | OEM                                  |       |                                       |
|         |                       | RITTAL                               |       |                                       |
|         |                       | PYROTECH                             |       |                                       |
| 33.     | RESISTANCE BOXES      | ENAPROS                              |       |                                       |
|         |                       | OEM                                  |       |                                       |
| 34.     | FIRE EXTINGUISHERS    | ASKA EQUIPMENTS LTD.                 |       |                                       |
|         |                       | ASHOKA ENGINEERING COMPANY           |       |                                       |
|         |                       | KANADIA FYR FYTER PVT. LTD           |       |                                       |
|         |                       | NITIN FIRE PROTECTION INDUSTRIES LTD |       |                                       |
|         |                       | NEW ENGINEERING CORPORATION          |       |                                       |
|         |                       | SAFEX FIRE SERVICES LTD              |       |                                       |
|         |                       | UNITED FIRE EQUIPMENTS PVT. LTD      |       |                                       |
|         |                       | ZENITH FIRE SERVICES (INDIA) PVT LTD |       |                                       |
| 35.     | VVVF                  | YASKAWA                              |       |                                       |
|         |                       | ABB                                  |       |                                       |
|         |                       | SIEMENS                              |       |                                       |
|         |                       | SCHNIEDER                            |       |                                       |
|         |                       | FUJI ELECTRIC                        |       |                                       |
|         |                       | MITSUBISHI ELECTRIC                  |       |                                       |
| 36.     | SHROUDED DSL          | SUSHEEL                              |       |                                       |
|         |                       | STROMAG                              |       |                                       |
| 37.     | ANTI COLLISION DEVICE | ELECTRONIC SWITCHES INDIA            |       |                                       |
| 38.     | LOAD CELL             | IPA                                  |       |                                       |
|         |                       | SARTORIUS                            |       |                                       |
| 39.     | RRC                   | ACROPOLIS ENGINEERING                | -     |                                       |
|         |                       | SNT CONTROLS                         | -     |                                       |
| 40.     | GEAR BOX              | OEM                                  |       | * = Applicable for Geared Motors only |
|         |                       | ELECON ENGINEERS                     |       |                                       |
|         |                       | SHANTI GEARS                         |       |                                       |
|         |                       | PBL*                                 |       |                                       |
|         |                       | NAW*                                 |       |                                       |
|         |                       | NORD*                                |       |                                       |
|         |                       | SEW*                                 |       |                                       |



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|------------|------|--------------|-------|---------|
|            |      | BONGFILIOLI* |       |         |
| 41.        | RAIL | JSPL         |       |         |
|            |      | SAIL         |       |         |

**NOTE:**

1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND NTPC APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL
2. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.
3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.



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**ANNEXURE-II  
MANDATORY SPARES**

| Sl. No. | DESCRIPTION                                     | QUANTITY |
|---------|-------------------------------------------------|----------|
| 1       | <b><i>Spares for long travel unit</i></b>       |          |
| i       | Set of axle bearings                            | 1 set    |
| ii      | Set of gearbox bearings with sleeves            | 1 set    |
| iii     | Long travel end shaft bearings                  | 1 set    |
| iv      | Coupling                                        | 1 set    |
| v       | Seals for travel gear box                       | 1 set    |
| vi      | Long travel brake shoes                         | 1 set    |
| vii     | Long travel brake springs                       | 1 set    |
| viii    | Long travel brake shoe liners                   | 1 set    |
| 2       | <b><i>Spares for cross travel unit</i></b>      |          |
| i       | Axle bearings                                   | 1 set    |
| ii      | Set of gearbox bearings with sleeves            | 1 set    |
| iii     | Set of seals for gearbox                        | 1 set    |
| iv      | Cross travel end shaft bearing                  | 1 set    |
| v       | Coupling                                        | 1 set    |
| vi      | Cross travel brake shoes                        | 1 set    |
| vii     | Cross travel brake springs                      | 1 set    |
| viii    | Cross travel brake shoe liners                  | 1 set    |
| 3       | <b><i>Spares for main hoist</i></b>             | 1 Set    |
| i       | Main hoist pulley bearings                      | 1 set    |
| ii      | Set of bearings for rope drum                   |          |
| iii     | Set of bearings for gear box                    | 1 set    |
| iv      | Set of seals for main hoist                     | 1 set    |
| v       | Main hoist brake shoes                          | 1 set    |
| vi      | Main hoist brake springs                        | 1 set    |
| vii     | Main hoist brake shoe liners                    | 1 set    |
| viii    | Disc pad                                        | 1 set    |
| 4       | <b><i>Spares for auxiliary hoist</i></b>        |          |
| i       | Aux hoist pulley bearings                       | 1 set    |
| ii      | Set of bearings for rope drum                   |          |
| iii     | Set of bearings for gear box                    | 1 set    |
| iv      | Set of seals for aux. hoist                     | 1 set    |
| v       | aux. hoist brake shoes                          | 1 set    |
| vi      | aux. hoist brake springs                        | 1 set    |
| vii     | aux. hoist brake shoe liners                    | 1 set    |
| viii    | Pair of slings                                  | 1 set    |
| ix      | Disc pad                                        | 1 set    |
| 5       | <b><i>Electrical: control panels/motors</i></b> |          |
| i       | Power contactor of each rating                  | 2 nos.   |



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|      |                                                   |                                                        |
|------|---------------------------------------------------|--------------------------------------------------------|
| ii   | Over load relays of each rating                   | 2 nos.                                                 |
| iii  | MCCB/MPCB of each rating                          | 2 nos.                                                 |
| iv   | Push button of each type                          | 2 nos.                                                 |
| v    | VVVF drive of each type & rating                  | 1 no.                                                  |
| vi   | Set of bearings for main hoist motor              | 1 set                                                  |
| vii  | Set of bearings for aux hoist motor               | 1 set                                                  |
| viii | Set of bearings for cross travel motor            | 1 set                                                  |
| ix   | Set of bearings for long travel motor             | 1 set                                                  |
| 6    | <b><i>Motors of each type and rating</i></b>      |                                                        |
| a)   | Driving end bearing                               | 1 set                                                  |
| b)   | Non driving end bearing                           | 1 set                                                  |
| c)   | Terminal block for motors up to 30 Kw each rating | 10 Nos.                                                |
| d)   | Terminal block for motors above 30 Kw each rating | 5 Nos.                                                 |
| e)   | Motors of each type & rating                      | 1 no. or 10% of installed quantity whichever is higher |

NB: Items at sl no. 1 to 5 shall be 1 lot applicable for each crane (i.e. 7 set is required). For items at sl no. 6, items are common for all cranes. (refer unpriced schedule for detail)

**NOTES**

- Set for the particular equipment, would include all components required to replace the item, for example a set of bearing shall include all hardware normally required while replacing the bearings. It is further, intended that the assembly / sub-assembly which have different orientation (like left hand or right hand, top or bottom), different direction of rotation or mirror image positioning or any other reasons which result in maintaining two different sets of the spares to be used for the subject assembly / sub-assembly, these shall be considered as different types of assembly/sub-assembly. One (1) set means 100% requirement for one crane.
- Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed.
- In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.
- Any item which is quoted as "not applicable" in the above list and is found to be "applicable" at a later date shall be supplied by the Bidder without any commercial implications. The Bidder shall note that if there is any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.



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- 5 Mandatory spares shall not be dispatched before dispatch of corresponding main equipment. The spares shall be treated and packed for a long storage under the climatic condition prevailing at site.
- 6 *Interchangeability and Packings:*  
All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares should include all mounted accessories like components, boards, add or items, fitting, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require any additional item. The vendors must conform the pair to pair compatibility of each electrical spares modules with the modules should be supplied in the original package. All electronic modules should be pre-set and/or preprogrammed for ready use at site. Alternatively, suitable instruction sheet indicating the details of required PCB jumper position, BCD which is setting, EPROM/PROM listing etc. should be packed along with each module. Also a caution mark sign should be put on all such module which needs pre-setting/pre-programming before putting them in to service. The spare shall be treated and properly packed for long term storage.
- 7 *Identification:*  
Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents 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 purpose of identification.
- 8 Mandatory spares listed above is bare minimum requirement. In case any additional mandatory spares requirement is covered elsewhere in the tender specification, same shall be deemed to have been covered in bidder's scope of supply.



**TECHNICAL SPECIFICATION  
FOR  
2x660 MW UDANGUDI TPP-STAGE I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T)**

**SECTION-I**

**SUB-SECTION-IA**

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**ANNEXURE-III  
TOOLS & TACKLES**

A complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual for the crane shall be supplied. Each tool and wrench shall be stamped so as to be identified, easy for its use. The tools shall be supplied in steel toolbox and with a copy of instruction manual. The items supplied shall be of the best quality and minimum the following shall be provided.

| <b>S-No.</b> | <b>Description</b>                                                | <b>Qty.</b>                                                  |
|--------------|-------------------------------------------------------------------|--------------------------------------------------------------|
| 1            | Complete set of ring spanners<br>(Indicate the sizes offered)     | 1 Set                                                        |
| 2            | Complete set of screwdrivers<br>(Min. 6 Nos., Indicate the sizes) | 1 Set                                                        |
| 3.           | Adjustable Spanner                                                | 1 No.                                                        |
| 4.           | Insulated plier                                                   | 1 No.                                                        |
| 5            | Wrench spanner                                                    | 1 No.                                                        |
| 6.           | Grease Gun                                                        | 1 No.                                                        |
| 7.           | Oil Gun.                                                          | 1 No.                                                        |
| 8.           | Hand Lamp.                                                        | 1 No.                                                        |
| 9            | Line tester                                                       | 1 No.                                                        |
| 10.          | Hydraulic jacks<br>.                                              | 2 nos. (20T capacity or higher for<br>maintenance of cranes) |

Note: - One set of tool and tackles with O&M manual in the toolbox shall be supplied. Further in addition to above mentioned items, if any other items is required for maintenance of cranes, the same shall also be included as a part of maintenance tools by the bidder.



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**ANNEXURE-IV  
PAINTING SPECIFICATION**

**Structural**

- Surface Prep – SA 2-1/2
- Primer – Solvent Based IZS – VS of 60%, n Dust – 1.77 kg/ltr minimum, Zn dust by weight – minimum 85%, Pot life of 12 hours/ 21 Deg. Paint to meet compositional & performance specifications for SSPC Paint 20, Level 1. 1 Coat total DFT 75 Microns
- Touch up - Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2. 1 Coat total DFT 75 Microns
- Mid Coat - 2 pack High build High Solid Lamellar MIO based Epoxy Mid coat 1 Coat Total DFT 200 microns
- Finish - 2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUUV exposure of minimum 1000 hrs. 1 coat Total 75 microns
- Total DFT shall be 350 Microns

**Motors**

- Surface Prep – SA 2-1/2
- Primer - Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2. 1 coat Total DFT 75 microns
- Finish - Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%. 2 Coats Total DFT 100 Microns
- Total DFT 275 Microns

**Panels**

- Surface Prep – SA 2-1/2
- Primer - Two pack, high build siloxane modified epoxy primer with zinc phosphate pigment. Total DFT 75 microns
- Mid Coat - Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide 1 coat total DFT 100 microns
- Top Coat - Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%. 1 Coats Total DFT 100 Microns
- Total DFT 275 Microns

**Color Shade:**

| SL. No | Item Description | Color Shade                         | Remarks |
|--------|------------------|-------------------------------------|---------|
| 1      | Crane Structure  | Golden Yellow shade 356 as per IS-5 |         |
| 2      | Trolley and hook | Golden Yellow shade 356 as per IS-5 |         |
| 3      | Motors           | Light Gray shade 631 as per IS-5    |         |
| 4      | Control Panels   | Light Gray as per IS-5              |         |



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**PACKAGE: DOUBLE GIRDER EOT CRANE  
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**ANNEXURE-V  
MAIN DRAWING LIST WITH SCHEDULE OF SUBMISSION**

**A. DRAWINGS/ DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

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

**BASIC ENGINEERING DRAWINGS/DOCUMENTS**

| S.N                     | BHEL drawing No.   | Title                                                                                                        | Approval category | Schedule date of submission from date of LOI. |
|-------------------------|--------------------|--------------------------------------------------------------------------------------------------------------|-------------------|-----------------------------------------------|
| 1                       | PE-V0-435-501-A101 | Manufacturing Quality Plan with sub vendor list For D/G EOT CRANE UPTO 100T                                  | A                 | 3                                             |
| 2                       | PE-V0-435-501-A104 | Mechanism Sizing Calculation for D/G EOT CRANE UPTO 100T                                                     | A                 | 3                                             |
| 3                       | PE-V0-435-501-A105 | General arrangement for D/G EOT CRANE UPTO 100T with CT DSL details                                          | A                 | 3                                             |
| 4                       | PE-V0-435-501-A106 | Crab sub assembly for D/G EOT CRANE UPTO 100T with CT wheel assembly                                         | I                 | 4                                             |
| 5                       | PE-V0-435-501-A109 | Main and Auxiliary hook block assembly with details of hook, nut and check plate For D/G EOT CRANE UPTO 100T | I                 | 4                                             |
| 6                       | PE-V0-435-501-A132 | Gantry Rail installation for D/G EOT CRANE UPTO 100T                                                         | I                 | 4                                             |
| LEGENDS                 |                    |                                                                                                              |                   |                                               |
| A= Approval category    |                    |                                                                                                              |                   |                                               |
| I= Information category |                    |                                                                                                              |                   |                                               |

**OTHER DRAWING/DOCUMENTS**

| S.N | BHEL drawing No.   | Title                                                                | Approval category | Schedule date of submission                                                                              |
|-----|--------------------|----------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------|
| 1   | PE-V0-435-501-A103 | Data sheet of motors for D/G EOT CRANE UPTO 100T                     | I                 | 14 days after CAT II approval /clearance from BHEL on Mechanical sizing calculation (PE-V0-435-501-A104) |
| 2   | PE-V0-435-501-A108 | General arrangement for PVC shrouded DSL for D/G EOT CRANE UPTO 100T | I                 | 7 days after CAT II approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)                     |



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|----|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3  | PE-V0-435-501-A110 | Long travel Machinery Assembly with LT wheel assembly For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                       | I | 14 days after CAT II approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)                                                                 |
| 4  | PE-V0-435-501-A114 | O & M Manual For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                                                | I | 28 days after CAT II approval /clearance from BHEL on G.A. of Crane , Mechanical sizing calculation & Schematic Circuit diagram                       |
| 5  | PE-V0-435-501-A115 | Detailed BOM/BOQ for D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                                            | I | 28 days after CAT II approval /clearance from BHEL on G.A. of Crane , Mechanical sizing calculation & Schematic Circuit diagram                       |
| 6  | PE-V0-435-501-A117 | "Schematic circuit diagram of a) Protective panel, Main and lighting circuit & BOM b) Main hoist panel & BOM c) Aux. hoist panel & BOM d) Cross Traverse & BOM e) Long Traverse & BOM Including earthing diagram For D/G EOT CRANE UPTO 100T (BFP crane, CWPH crane, Workshop crane, heavy material store crane, Sea water intake PH crane, Sea water outfall PH crane) | A | 7 days after CAT II approval /clearance from BHEL on Mechanical sizing calculation (PE-V0-435-501-A104)                                               |
| 7  | PE-V0-435-501-A118 | General Arrangement of a) Protective panel b) Main hoist panel c) Aux. hoist panel d) Cross Travel panel e) Long Traverse travel panel. f) Pendent g) Remote Radio Control For D/G EOT CRANE UPTO 100T (BFP crane, CWPH crane, Workshop crane, heavy material store crane, Sea water intake PH crane, Sea water outfall PH crane)                                       | I | 7 days after CAT II approval /clearance from BHEL on electrical scheme (PE-V0-435-501-A117)                                                           |
| 8  | PE-V0-435-501-A119 | Cable Sizing and cable schedule For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                             | A | 7 days after CAT II approval /clearance from BHEL on electrical scheme (PE-V0-435-501-A117)                                                           |
| 9  | PE-V0-435-501-A120 | Crane Operational write up For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                                  | I | Along with electrical scheme (PE-V0-435-501-A117)                                                                                                     |
| 10 | PE-V0-435-501-A121 | Type test certificate (for motors) For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                          | A | 14 days after CAT II approval /clearance from BHEL on                                                                                                 |
| 11 | PE-V0-435-501-A123 | Mandatory spare parts list For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                                  | A | 14 days after CAT II approval /clearance from BHEL on G.A. of Crane , Mechanical sizing calculation, technical data sheet & Schematic Circuit diagram |
| 12 | PE-V0-435-501-A125 | Erection procedure For D/G EOT CRANE UPTO 100T                                                                                                                                                                                                                                                                                                                          | I | 28 days after CAT II approval /clearance from                                                                                                         |



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|                         |                    |                                                             |   |                                                                                            |
|-------------------------|--------------------|-------------------------------------------------------------|---|--------------------------------------------------------------------------------------------|
|                         |                    |                                                             |   | BHEL on G.A. of Crane ,<br>Mechanical sizing<br>calculation & Schematic<br>Circuit diagram |
| 13                      | PE-V0-435-501-A127 | Data sheet of D/G EOT CRANE UPTO 100T with painting details | A | 7 days after CAT II approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)       |
| 14                      | PE-V0-435-501-A132 | Gantry Rail installation for D/G EOT CRANE UPTO 100T        | I | 7 days after CAT II approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)       |
| 15                      | PE-V0-435-501-A150 | Crane lubrication drawing For D/G EOT CRANE UPTO 100T       | I | 14 days after CAT II approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)      |
| 16                      | PE-V0-435-501-A112 | Structural calculations For D/G EOT CRANE UPTO 100T         | A | 14 days after CAT II approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)      |
| 17                      | PE-V0-435-501-A151 | Field quality plan For D/G EOT CRANE UPTO 100T              | A | 7 days after CAT I approval /clearance from BHEL on GA drawing (PE-V0-435-501-A105)        |
| <b>LEGENDS</b>          |                    |                                                             |   |                                                                                            |
| A= Approval category    |                    |                                                             |   |                                                                                            |
| I= Information category |                    |                                                             |   |                                                                                            |

**Notes:**

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
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.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. Bidder to note that all values/dimensions/elevations etc. without supporting back up data adopted/assumed by the successful bidder (during contract stage) in the design calculation/drawings shall be taken by the customer/owner to be correct unless they are stipulated in the specification. Any problem arising later in this regard shall be made good by the successful bidder at his cost and no extension of time shall be granted for the same.
5. 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.:-



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- a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
- b) 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.
- c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
- d) 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.
- e) 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.
- f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
- g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
- h) All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No.
- i) 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.
- j) Bidder to follow the following the drawing submission schedule:
  - i. 1st submission of drawings from date of LOI as per the submission schedule.
  - ii. Every revised submission incorporating comments – within 7 days.
- k) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.
- l) **" DOCUMENTATION " at clause no. 4.0.0 of customer specification also to be referred for finalizing drawing list during detail engineering.**



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**B. DOCUMENT MANAGEMENT SYSTEM:**

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 dwg/ document distribution schedule. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized after award of contract.

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>

**C.**

**Distribution of documents**

The source, distribution, no. of copies etc shall be as per the following document distribution schedule.

**Document Distribution Schedule - After Placement of Order**

| Sl.No. | Document                                                                                                                   | Total<br>Copies | Distribution |      |            |
|--------|----------------------------------------------------------------------------------------------------------------------------|-----------------|--------------|------|------------|
|        |                                                                                                                            |                 | Owner        |      | Consultant |
|        |                                                                                                                            |                 | HQ           | SITE |            |
| 1.     | PERT Network, work schedules, Bar charts, Layout drawings in 2D & 3 D of all building, plant, pump house, control room etc | 12              | 4            | 6    | 2          |
| 2.     | Data, drawings, documents, write-ups, calculation                                                                          |                 |              |      |            |
|        | - Preliminary                                                                                                              | 12              | 5            | 5    | 2          |
|        | - Revised                                                                                                                  | 12              | 4            | 6    | 2          |
| 3.     | Approved drawings, documents etc.                                                                                          | 12              | 4            | 6    | 2          |
| 4.     | Instruction manuals for erection and O&M                                                                                   | 12              | 5            | 6    | 1          |
| 5.     | As built drawings including O &M manual                                                                                    |                 |              |      |            |
|        | - Hard Copy                                                                                                                | 12              | 5            | 6    | 1          |
|        | - Soft Copy                                                                                                                | 5               | 2            | 2    | 1          |



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**ANNEXURE-VI  
PACKING PROCEDURE**

Packing and Marking:

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement.

Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.



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**ANNEXURE-VII  
SHOP TEST PROCEDURE FOR GEAR BOXES & LOAD/ OVERLOAD TESTING OF EOT CRANE AT  
MANUFACTURER'S WORKS**

**A. SHOP TEST PROCEDURE FOR GEAR BOX (Procedure No. PEM (Q)/001)**

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1.0.0</b> | <b>Scope: Acceptance Norms for Crane Gear Boxes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>1.1.0</b> | <p>This procedure lays down the Acceptance norms for the Gear boxes for EOT crane. This standard also covers vertical gear boxes.</p> <p>Reduction Gears shall be tested for reduction ratio, backlash &amp; contact pattern. Gear Box shall also be subjected to No load run test to check for oil leakage, temp. rise, noise and vibration.</p>                                                                                                                                                                   |
| <b>2.0.0</b> | <b>The following dimensions shall be checked:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>2.1.0</b> | <ul style="list-style-type: none"> <li>i. Diameter and keyway dimensions of input and output shafts.</li> <li>ii. Projection of input and output shafts beyond foundation holes and Centre lines of gear box.</li> <li>iii. Centre distance between input and output shafts.</li> <li>iv. Centre Height.</li> <li>v. Distance between foundation holes with respect to center line of the output shaft and distance of foundation holes from center line of the gearbox.</li> <li>vi. Overall dimensions</li> </ul> |
| <b>3.0.0</b> | <b>Backlash</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>3.1.0</b> | <p>The back lash shall be checked by dial gauge preferably (refer Figure –1). Lead wire may be also be used but final decision in case of dispute shall be taken by using dial gauge. The backlash shall be within the limits specified in the drawing. If the value of the backlash allowed is not specified in the drawing, the allowed backlash shall be a given in Table-1</p>                                                                                                                                  |
| <b>4.0.0</b> | <b>Area of Contact:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>4.1.0</b> | <p>Area of contact shall be taken by applying Prussian blue. The contact area shall be within the limits mentioned below (refer Figure –2)</p> <p>For final stage of Hoist gearing:</p> <p><math>h / H</math> shall be more than 30%</p> <p><math>(a - c) / b</math> shall be more than 40%</p> <p>For all other gears:</p> <p><math>h / H</math> shall be more than 40%</p>                                                                                                                                        |



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|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | (a – c) / b shall be more than 50%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>5.0.0</b> | Running Test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5.1.0        | <p>1.1.1 The gear boxes shall be run under no-load condition at the rated speed for minimum four hours in each direction and the following are to be checked:</p> <ul style="list-style-type: none"> <li>i. All bolts at the joints remain tight</li> <li>ii. All gear mesh lines are getting enough lubrication</li> <li>iii. All bearings are getting enough lubrication</li> <li>iv. Bearing temperatures after running for four hours shall not exceed 50 deg. Centigrade or 15 deg. centigrade above ambient whichever is higher. Temperature shall be checked after every hour.</li> <li>v. Vibration : Maximum limit 125 microns (peak to peak)</li> <li>vi. Sound: The gearbox shall not emit unusual sound as obtained under conditions of hard meshing, high spots etc. Maximum sound level shall be 85 dBA at a distance of 1000mm and 91 dBA at a distance of 300 mm.</li> <li>vii. There shall be no Oil leakage at parting lines, bearing housings or inspection covers.</li> </ul>                                                     |
| <b>6.0.0</b> | 1.1.2 General                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 6.1.0        | <p>1.1.3 In addition to the above specific points, the following general points shall be ensured:</p> <ul style="list-style-type: none"> <li>i. Inspection pockets are provided as required.</li> <li>ii. Gear box casings are provided with at least two fit bolts/dowels at the parting line.</li> <li>iii. Dip sticks with minimum / maximum level markings are provided.</li> <li>iv. Drain plugs are provided at convenient locations preferably at vertical wall of the housing.</li> <li>v. Breathers are provided.</li> <li>vi. Lifting lugs or eye bolts are provided as required.</li> <li>vii. Wherever bearings have splash lubrication, oil retainers are provided.</li> <li>viii. Gear boxes are painted as per specification outside and inside. Inside surfaces shall be painted with Oil proof paint.</li> <li>ix. In case of vertical gear boxes having more than two stage reduction, forced lubrication is also provided.</li> </ul> <p>1.1.4 Name plate should provide information eg. Ratio, KW rating, Bearing details and</p> |



**TECHNICAL SPECIFICATION  
FOR  
2x660 MW UDANGUDI TPP-STAGE I  
DOUBLE GIRDER EOT CRANE UPTO 100T**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T)**

**SECTION-I**

**SUB-SECTION-IA**

**REV. 00**

**DATE: MAR 2020**

manufacturers name.

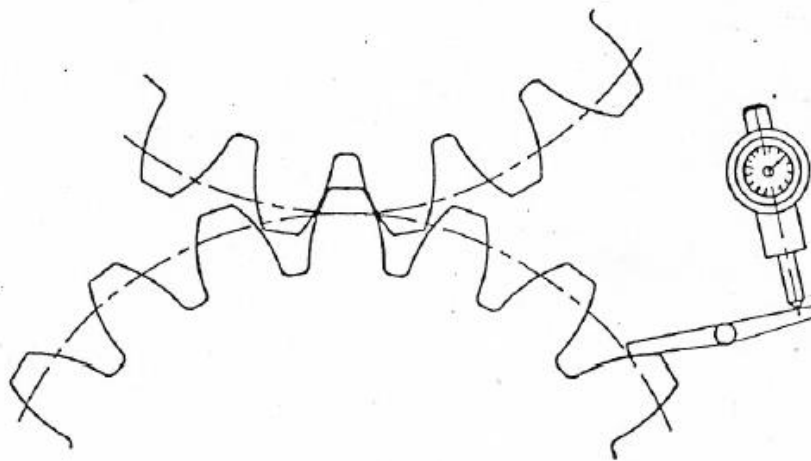


**FIG.1 MEASUREMENT OF BACKLASH**

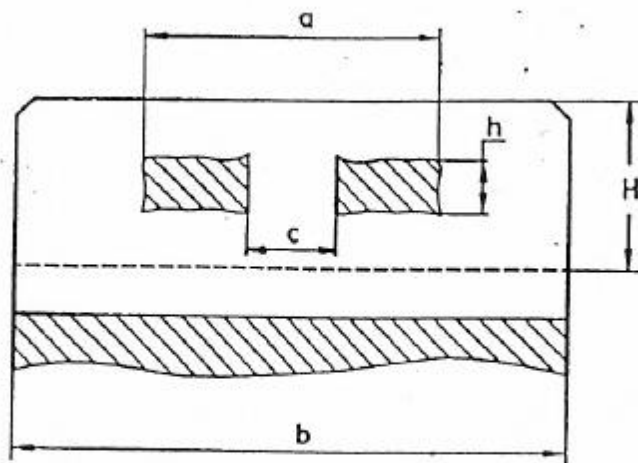


**FIG.2 AREA OF CONTACT OF GEAR TEETH**

**Table-1**



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**Backlash for Gearing specified by module**

**(Clause 3.1.0)**

| Centre distance in mm |      | Tolerances in microns |                                 |                              |
|-----------------------|------|-----------------------|---------------------------------|------------------------------|
| Above                 | Upto | Minimum               | Maximum                         |                              |
|                       |      |                       | For gears other than Drum gears | For Drum gears               |
|                       |      |                       | For all modules<br>1 to 50      | For all modules<br>2.5 to 50 |
| -                     | 50   | 85                    | 240                             | 280                          |
| 50                    | 80   | 105                   | 320                             | 380                          |
| 80                    | 120  | 130                   | 360                             | 420                          |
| 120                   | 200  | 170                   | 470                             | 530                          |
| 200                   | 320  | 210                   | 540                             | 640                          |
| 320                   | 500  | 260                   | 660                             | 740                          |
| 500                   | 800  | 340                   | 820                             | 880                          |
| 800                   | 1250 | 420                   | 970                             | 1040                         |
| 1250                  | 2000 | 530                   | 1200                            | 1280                         |
| 2000                  | 3150 | 710                   | 1500                            | 1670                         |
| 3150                  | 5000 | 850                   | 1810                            | 1980                         |

**B. Procedure for Load & Overload testing of Double Girder EOT Cranes at Manufacturer's Works**

**Objective:** To demonstrate final NO load, Load, Overload, Deflection & Functional tests of assembled crane/s for the purpose of acceptance.

**Basic Assumptions / Inputs for testing at Works:**

- Actual job hook shall be used for load & overload tests for hoisting.
- Actual ropes shall be used for load & overload testing.
- Shop cables can be used for temporary connection for the purpose of showing various functional tests at shop.
- Interlock and limit switch operation check will be shown with load for hoisting and CT motion.



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**Procedure for Load / Overload testing:**

The cranes shall be tested for no load, load test & overload test at works generally in conformance with the IS – 3177 (latest edition). Specifically with respect to the load / overload testing of crane, the following tests as per the outlined procedures shall be done at works.

- Deflection of the girder will be measured at SWL when the trolley with load is at the middle of the girder.
- No load and full load current of the motors will be measured to verify whether it is as per the approved data sheet of the motor. Resistors in the circuit will be checked for any overheating of the element.
- Overload relays will be checked for proper functioning.

**Hoisting & Cross Travel motions:**

The load will be gradually raised to 125 percent of the rated capacity (SWL) with actual hook.

The load will be lifted upward to about 1 meter height above its support and stop again.

Check for any undue drift in the load. If load drifts, check the adjustment of brakes and repeat the above procedure. Then lower the load to rest on support/ground.

For checking the cross travel, raise the load up to one (1) meter height above supports and then move the trolley with load about one (1) meter in either direction of the bridge. Then lower the load to rest on support/ ground.

Creep speed motions shall be checked over a distance of about 500 mm.

**Note: Complete No load, load & over load tests in line with IS-3177 (latest edition) shall also be done after erection of EOT crane at site.**



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**SECTION-I**

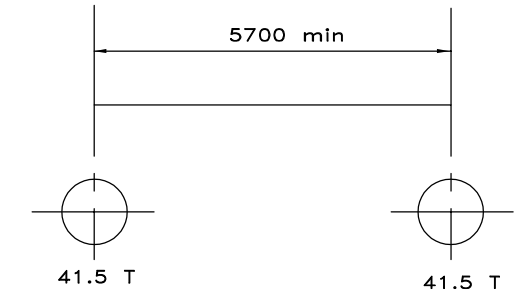
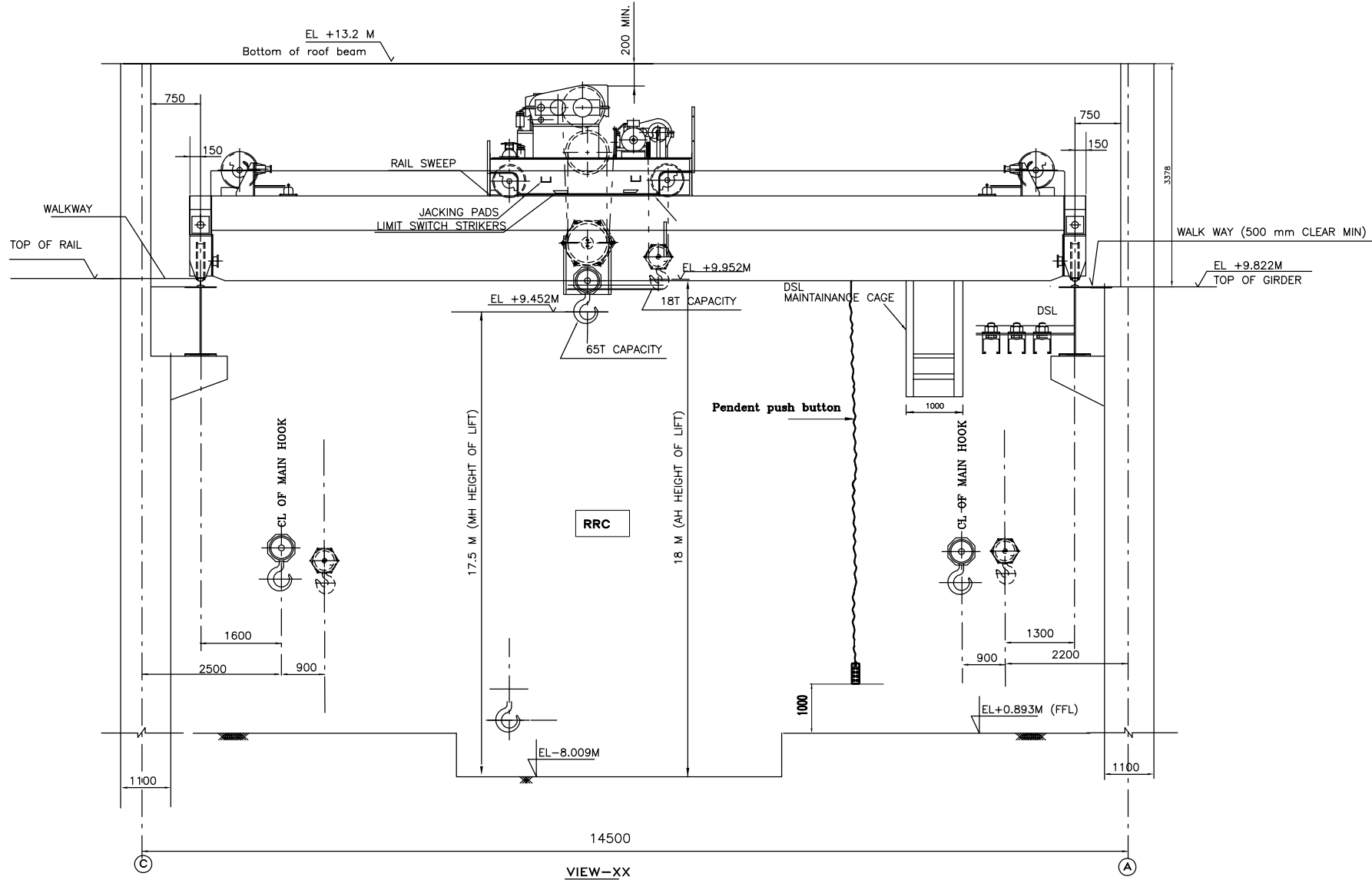
**SUB-SECTION-IA**

**REV. 00**

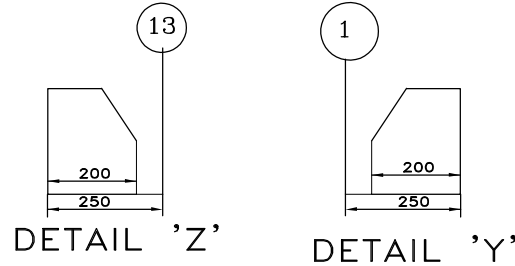
**DATE: MAR 2020**

**ANNEXURE-IX**  
**INPUT DRAWING**

PE-DG-435-501-A002

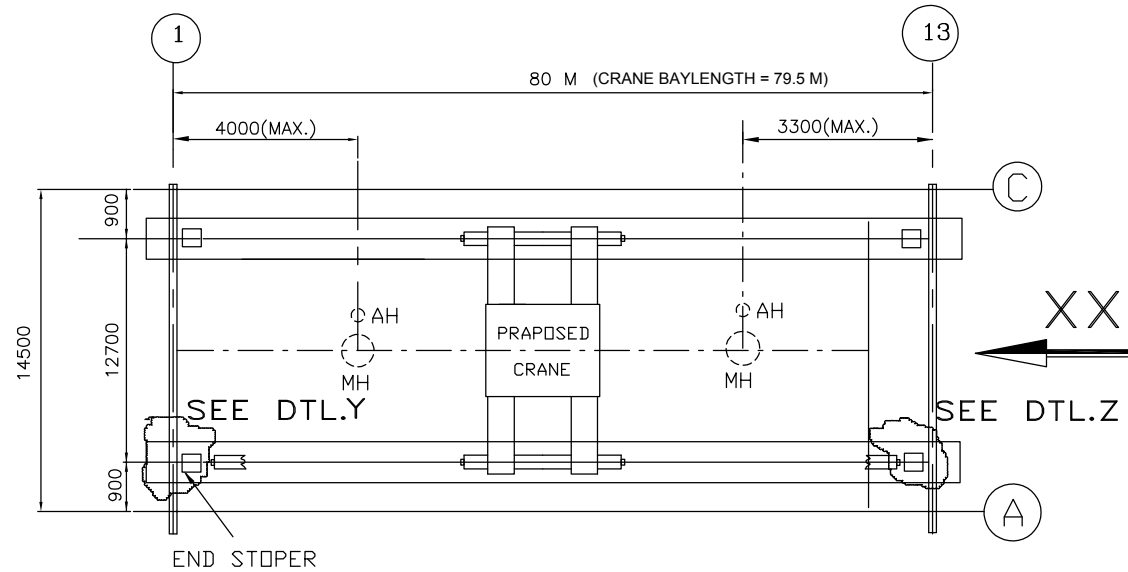


LT WHEEL LOAD DIAGRAM (WITHOUT IMPACT).

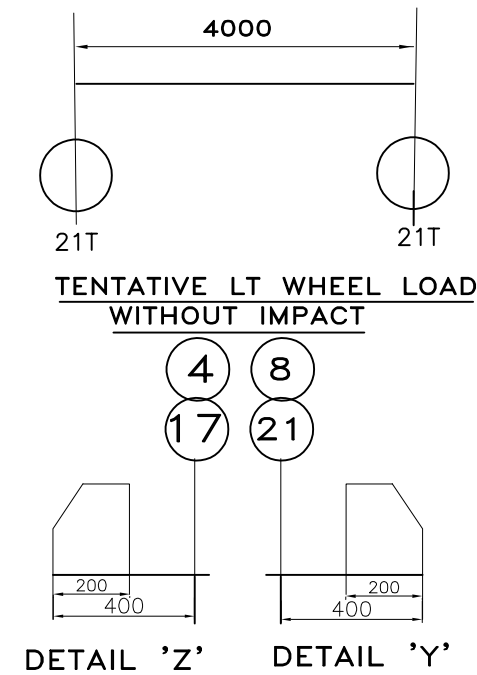


NOTES

- 1) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
- 2) DISTANCE BETWEEN CENTRE LINE OF COLUMN AND FACE OF COLUMN SHALL NOT EXCEED 150 MM

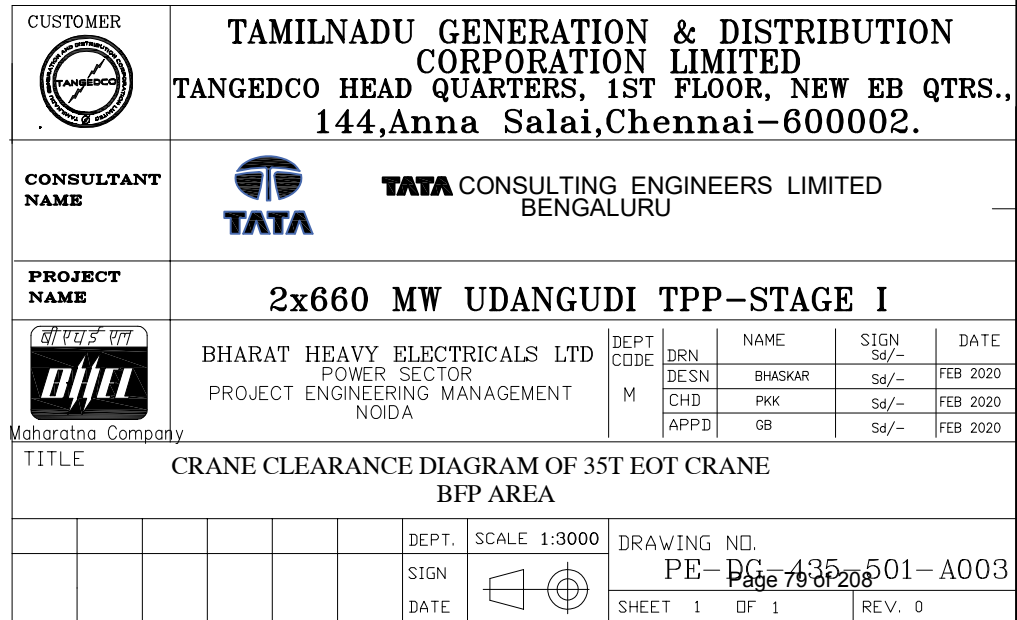


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|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------|---------|-------|--------------|--------------------|
| PROJECT                                                                 | TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED<br>TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS.,<br>144,Anna Salai,Chennai-600002. |        |         |       |              |                    |
| CONSULTANT NAME                                                         | TATA CONSULTING ENGINEERS LIMITED<br>BENGALURU                                                                                                |        |         |       |              |                    |
| PROJECT NAME                                                            | 2x660 MW UDANGUDI TPP-STAGE I                                                                                                                 |        |         |       |              |                    |
| Bharat Heavy Electricals Ltd<br>Project Engineering Management<br>Noida | DEPT CODE                                                                                                                                     | DRN    | NAME    | SIGN  | DATE         |                    |
|                                                                         | M                                                                                                                                             | DESIGN | BHASKAR | Sd/-  | FEB 2020     |                    |
|                                                                         |                                                                                                                                               | CHKD   | PK      | Sd/-  | FEB 2020     |                    |
|                                                                         |                                                                                                                                               | APPD   | GB      | Sd/-  | FEB 2020     |                    |
| TITLE CRANE CLEARANCE DIAGRAM OF 65/18T EOT CRANE FOR CWPB              |                                                                                                                                               |        |         |       |              |                    |
|                                                                         |                                                                                                                                               |        |         | DEPT. | SCALE 1:3000 | DRAWING NO.        |
|                                                                         |                                                                                                                                               |        |         | SIGN  |              | PE-DG-435-501-A002 |
|                                                                         |                                                                                                                                               |        |         | DATE  |              | Page 78 of 208     |
|                                                                         |                                                                                                                                               |        |         |       |              | SHEET 1            |

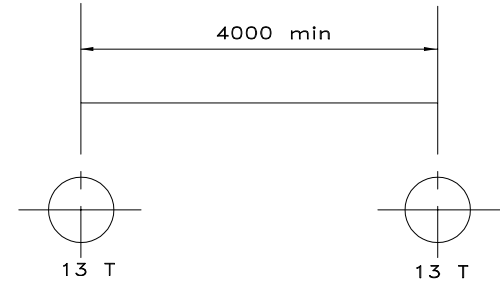
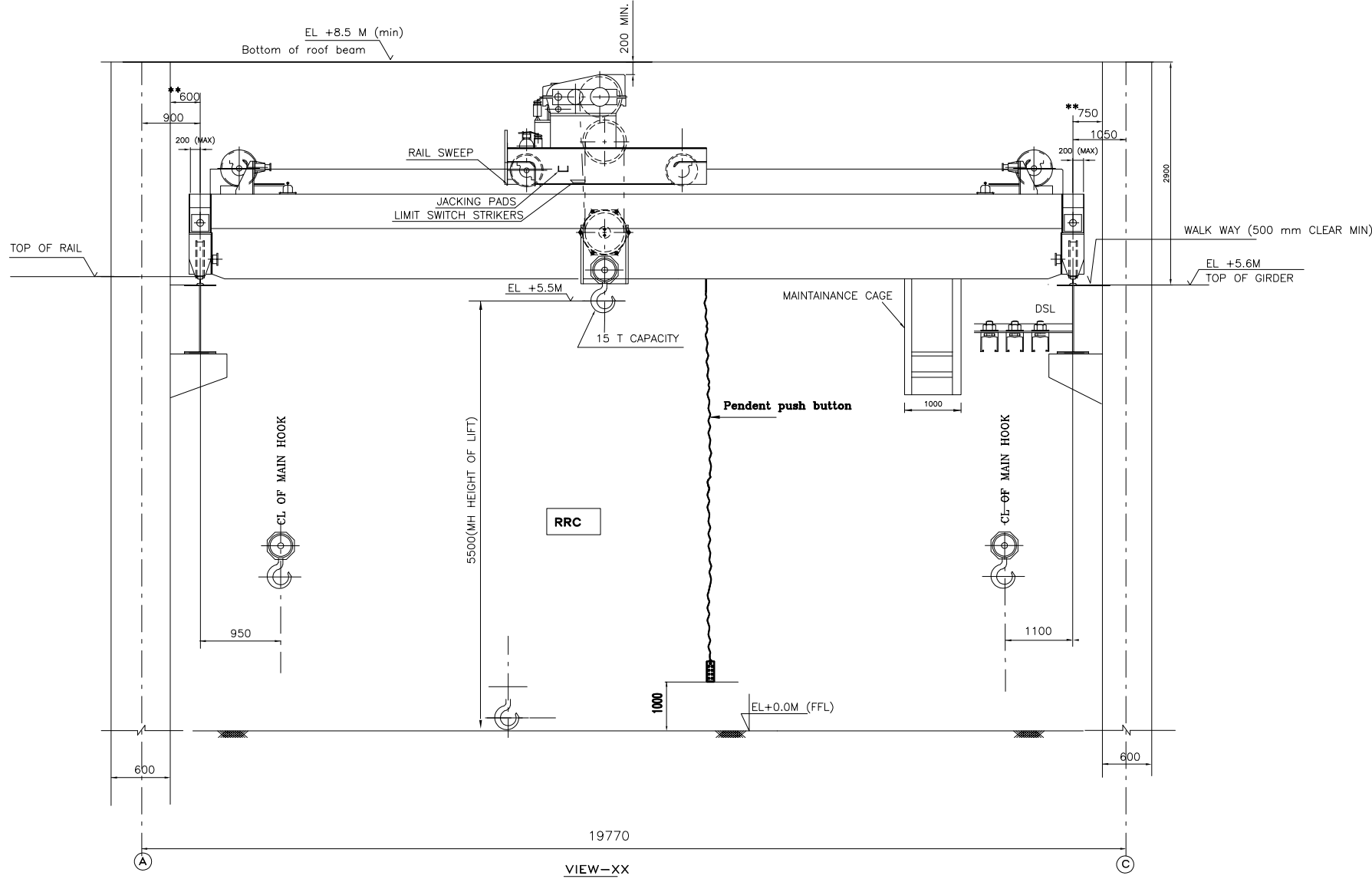


## NOTES

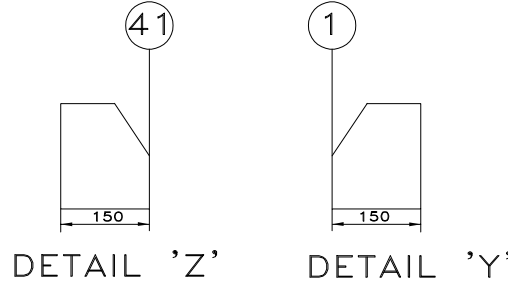
1) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.



PE-DG-435-501-A004

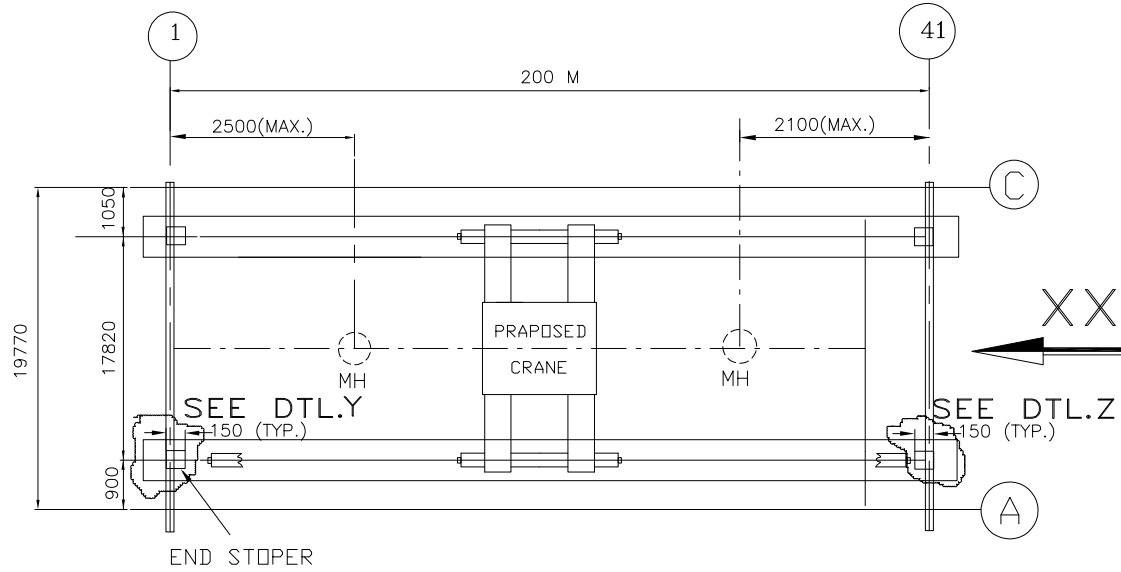


LT WHEEL LOAD DIAGRAM (WITHOUT IMPACT).

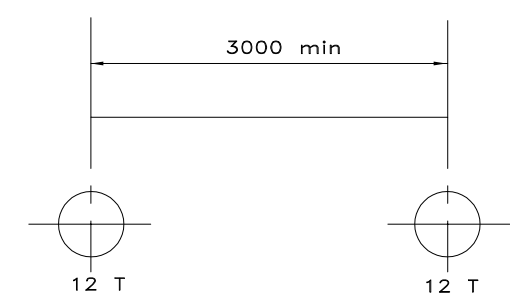


NOTES

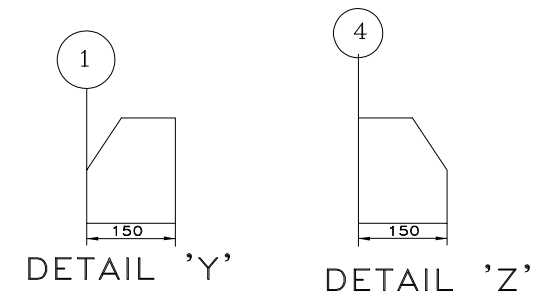
- 1) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
- 2) SPAN , LIFT , HOOK APPROACHES & BAYLENGTH ARE SUBJECT TO CHANGE AS PER CHANGE IN FINAL CIVIL STRUCTURE.



|                                                                           |                                                                                                                                               |           |              |                    |      |          |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------|--------------------|------|----------|
| PROJECT                                                                   | TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED<br>TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS.,<br>144,Anna Salai,Chennai-600002. |           |              |                    |      |          |
| CONSULTANT NAME                                                           | TATA CONSULTING ENGINEERS LIMITED<br>BENGALURU                                                                                                |           |              |                    |      |          |
| PROJECT NAME                                                              | 2x660 MW UDANGUDI TPP-STAGE I                                                                                                                 |           |              |                    |      |          |
| Maharatna Company                                                         | BHARAT HEAVY ELECTRICALS LTD                                                                                                                  | DEPT CODE | DRN          | NAME               | SIGN | DATE     |
|                                                                           | POWER SECTOR                                                                                                                                  | M         | DESN         | BHASKAR            | Sd/- | FEB 2020 |
|                                                                           | PROJECT ENGINEERING MANAGEMENT                                                                                                                |           | CHD          | PKK                | Sd/- | FEB 2020 |
|                                                                           | NOIDA                                                                                                                                         |           | APPD         | GB                 | Sd/- | FEB 2020 |
| TITLE<br>CRANE CLEARANCE DIAGRAM OF 15T EOT CRANE<br>HEAVY MATERIAL STORE |                                                                                                                                               |           |              |                    |      |          |
|                                                                           |                                                                                                                                               | DEPT.     | SCALE 1:3000 | DRAWING NO.        |      |          |
|                                                                           |                                                                                                                                               | SIGN      |              | PE-DG-435-501-A004 |      |          |
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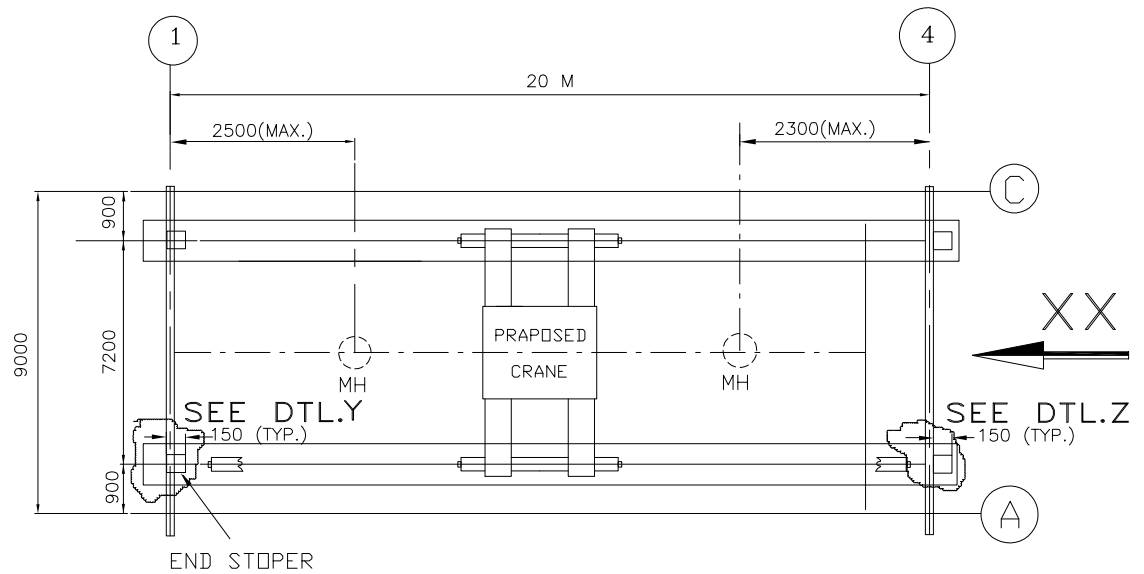
LT WHEEL LOAD DIAGRAM (WITHOUT IMPACT).



NOTES

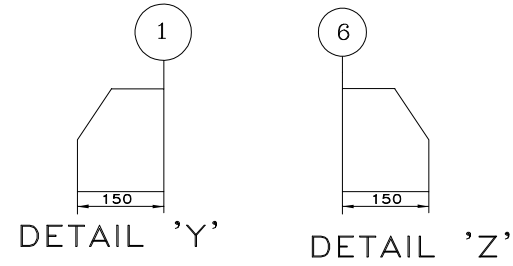
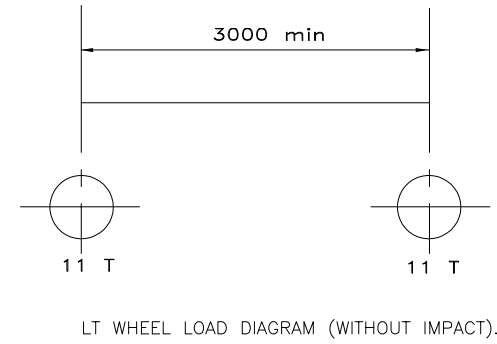
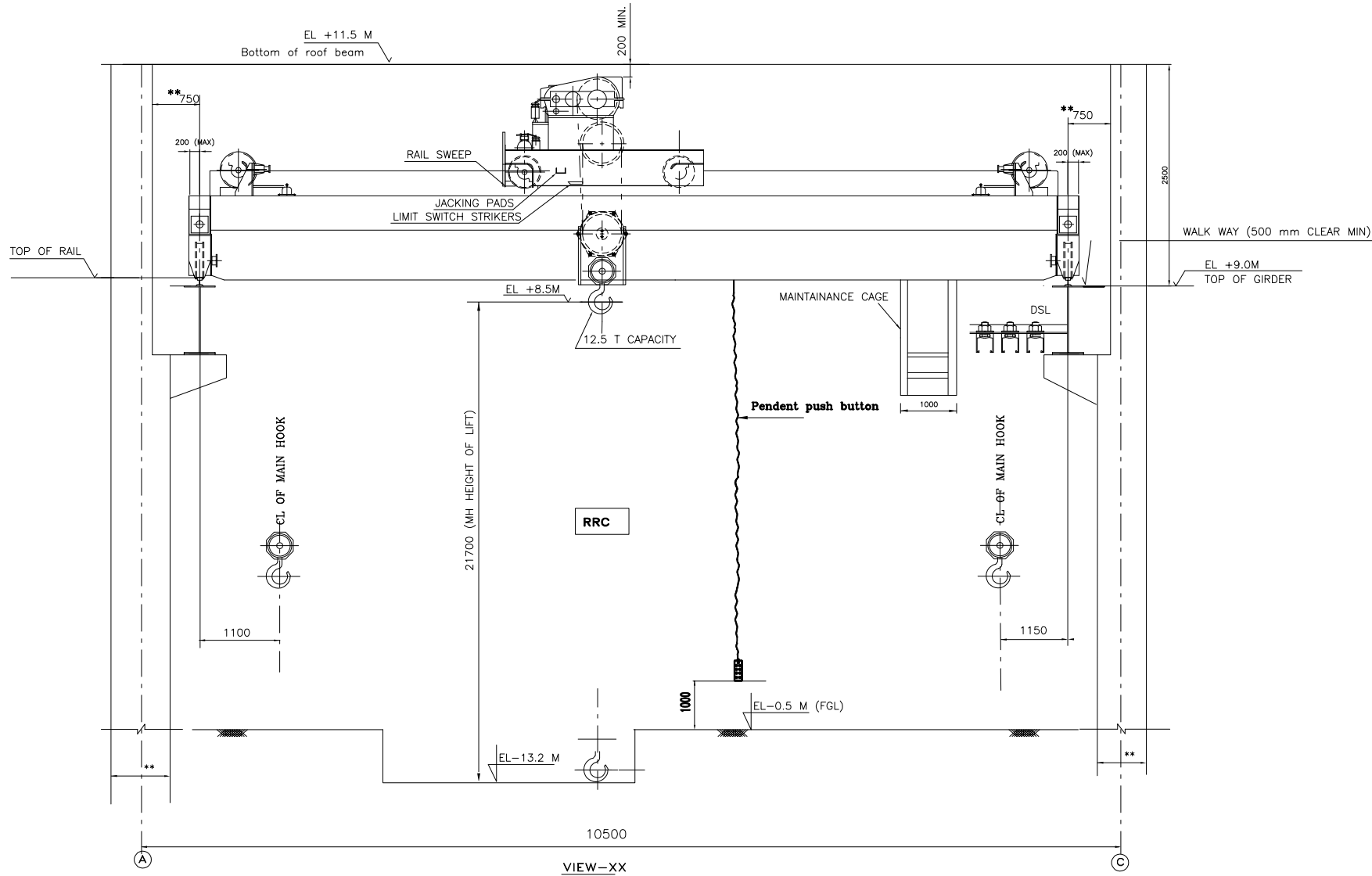
- 1) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
- 2) SPAN , LIFT , HOOK APPROACHES & BAYLENGTH ARE SUBJECT TO CHANGE AS PER CHANGE IN FINAL CIVIL STRUCTURE.
- 3) (\*\*) BOTH 'A' ROW and 'C' ROW COLUMNS ARE ASSUMED TO BE OF 1250 mm.

Ref drawing: PE-DG-435-172-N005 (MECHANICAL GA OF SEA WATER OUTFALL P/H



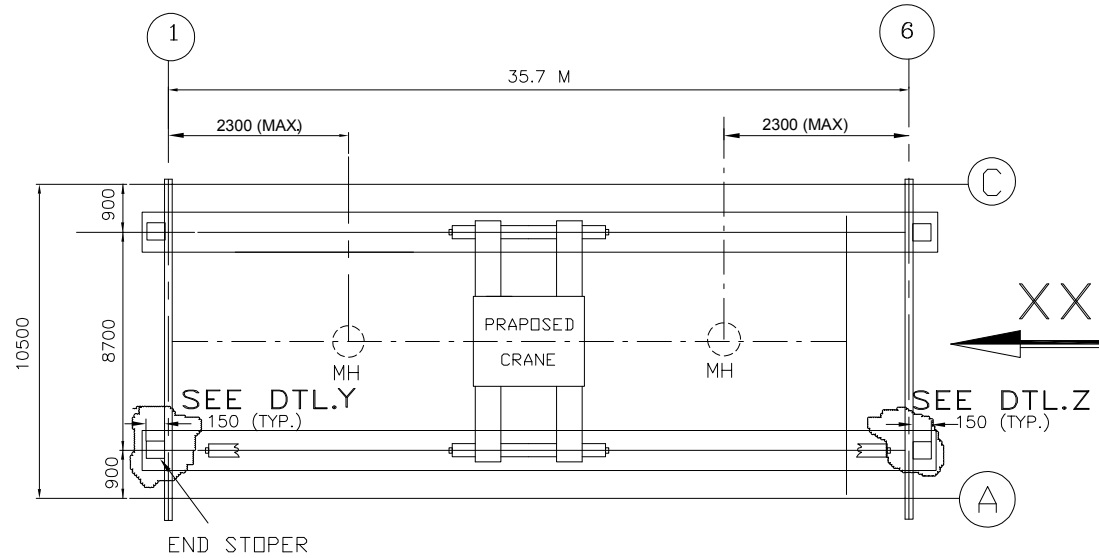
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| <b>CUSTOMER</b><br>        |  | <b>TAMILNADU GENERATION &amp; DISTRIBUTION CORPORATION LIMITED</b><br><b>TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS., 144,Anna Salai,Chennai-600002.</b> |  |                    |                            |                              |                                      |                                          |
| <b>CONSULTANT NAME</b><br> |  | <b>TATA CONSULTING ENGINEERS LIMITED</b><br><b>BENGALURU</b>                                                                                                 |  |                    |                            |                              |                                      |                                          |
| <b>PROJECT NAME</b>                                                                                             |  | <b>2x660 MW UDANGUDI TPP-STAGE I</b>                                                                                                                         |  |                    |                            |                              |                                      |                                          |
| <br>Maharatna Company      |  | BHARAT HEAVY ELECTRICALS LTD<br>POWER SECTOR<br>PROJECT ENGINEERING MANAGEMENT<br>NOIDA                                                                      |  | DEPT CODE<br><br>M | DRN<br>DESN<br>CHD<br>APPD | NAME<br>BHASKAR<br>PKK<br>GB | SIGN<br>Sd/-<br>Sd/-<br>Sd/-<br>Sd/- | DATE<br>JAN 2019<br>JAN 2019<br>JAN 2019 |
| TITLE                                                                                                           |  | CRANE CLEARANCE DIAGRAM OF 1ST EOT CRANE<br>SEA WATER OUTFALL PUMP HOUSE                                                                                     |  |                    |                            |                              |                                      |                                          |
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PE-DG-435-501-A004  
DRAWING NO.



#### NOTES

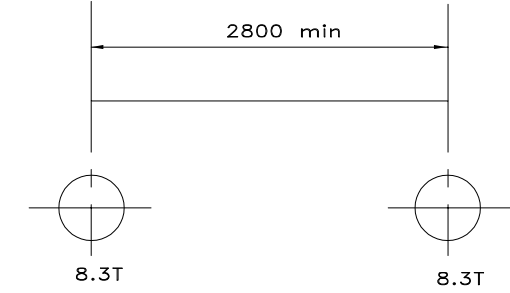
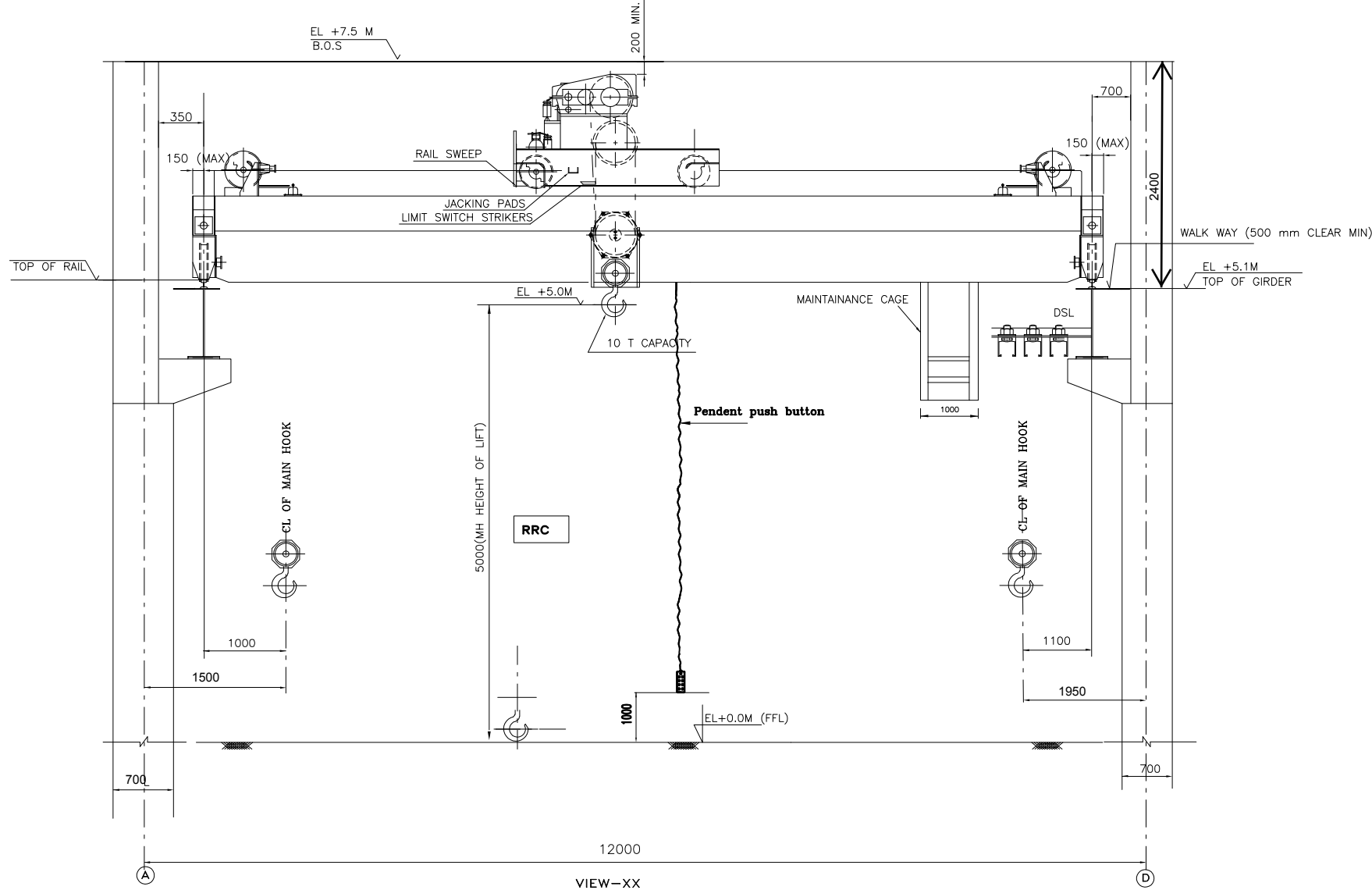
- 1) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
- 2) SPAN , LIFT , HOOK APPROACHES & BAYLENGTH ARE SUBJECT TO CHANGE AS PER CHANGE IN FINAL CIVIL STRUCTURE.
- 3) DISTANCE BETWEEN CENTRE LINE OF COLUMNS AND FACE OF COLUMNS HAVE BEEN ASSUMED AS 150MM



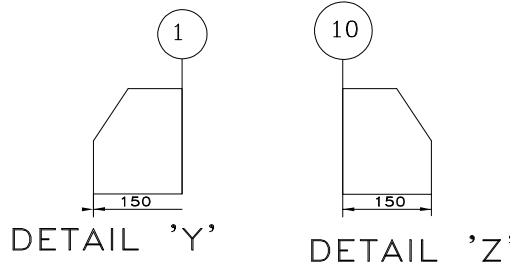
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|-----------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------|---------|-------|---------------------------------------------------------------------------------------|--------------------|--------|
| <b>CUSTOMER</b><br>        |  | <b>TAMILNADU GENERATION &amp; DISTRIBUTION CORPORATION LIMITED</b><br><b>TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS.,</b><br><b>144,Anna Salai,Chennai-600002.</b> |                    |       |         |       |                                                                                       |                    |        |
| <b>CONSULTANT NAME</b><br> |  | <b>TATA CONSULTING ENGINEERS LIMITED</b><br><b>BENGALURU</b>                                                                                                           |                    |       |         |       |                                                                                       |                    |        |
| <b>PROJECT NAME</b>                                                                                             |  | <b>2x660 MW UDANGUDI TPP-STAGE I</b>                                                                                                                                   |                    |       |         |       |                                                                                       |                    |        |
| <br>Maharatna Company      |  | BHARAT HEAVY ELECTRICALS LTD<br>POWER SECTOR<br>PROJECT ENGINEERING MANAGEMENT<br>NOIDA                                                                                | DEPT CODE<br><br>M | DRN   | NAME    | SIGN  | DATE                                                                                  |                    |        |
|                                                                                                                 |  |                                                                                                                                                                        |                    | DES N | BHASKAR | Sd/-  | FEB 2020                                                                              |                    |        |
|                                                                                                                 |  |                                                                                                                                                                        |                    | CHD   | PKK     | Sd/-  | FEB 2020                                                                              |                    |        |
|                                                                                                                 |  |                                                                                                                                                                        |                    | APPD  | GB      | Sd/-  | FEB 2020                                                                              |                    |        |
| TITLE<br>CRANE CLEARANCE DIAGRAM OF 12.5T EOT CRANE<br>SEA WATER INTAKE PUMP HOUSE                              |  |                                                                                                                                                                        |                    |       |         |       |                                                                                       |                    |        |
|                                                                                                                 |  |                                                                                                                                                                        |                    |       |         | DEPT. | SCALE 1:3000                                                                          | DRAWING NO.        |        |
|                                                                                                                 |  |                                                                                                                                                                        |                    |       |         | SIGN  |  | PE-DG-435-501-A006 |        |
|                                                                                                                 |  |                                                                                                                                                                        |                    |       |         | DATE  |                                                                                       | SHEET 1 OF 1       | REV. 0 |

PE-DG-435-501-A007

DRAWING No.



LT WHEEL LOAD DIAGRAM (WITHOUT IMPACT).



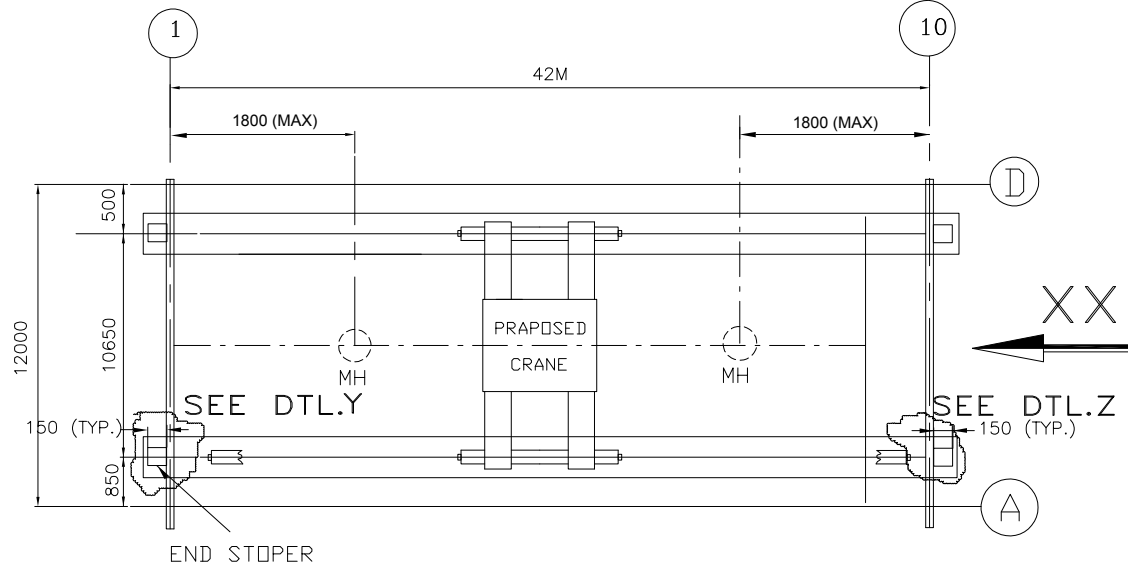
CRAB WEIGHT =2.8 tons (approx)  
CRANE WEIGHT= 13 tons (approx) including crab weight

NOTES

- 1) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
- 2) SPAN , LIFT , HOOK APPROACHES & BAYLENGTH ARE SUBJECT TO CHANGE AS PER CHANGE IN FINAL CIVIL STRUCTURE.

REFERENCE DRAWINGS:

- 1) PE-DG-435-645-C001 (WORK SHOP HOUSE -ARCH PLAN, ELEVATIONS AND SECTIONS.)
- 2) PE-DC-435-568-A001 (Design Memorandum for Workshop Equipment along with layout)
- 3) PE-DG-435-645-C0012 (WORK SHOP BLDG. - LAYOUT AND R.C. DTLs OF FDN)



|                                                                                                            |                                                                                         |                                                                                                                                            |                |                                                                                       |                       |                                   |                          |
|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------------------------------------------------------------------------------------|-----------------------|-----------------------------------|--------------------------|
| CUSTOMER<br>          |                                                                                         | TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED<br>TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS., 144,Anna Salai,Chennai-600002. |                |                                                                                       |                       |                                   |                          |
| CONSULTANT NAME<br>   |                                                                                         | TATA CONSULTING ENGINEERS LIMITED<br>BENGALURU                                                                                             |                |                                                                                       |                       |                                   |                          |
| PROJECT NAME                                                                                               |                                                                                         | 2x660 MW UDANGUDI TPP-STAGE I                                                                                                              |                |                                                                                       |                       |                                   |                          |
| <br>Maharatna Company | BHARAT HEAVY ELECTRICALS LTD<br>POWER SECTOR<br>PROJECT ENGINEERING MANAGEMENT<br>NOIDA |                                                                                                                                            | DEPT CODE<br>M | DRN<br>DESIGN<br>CHD                                                                  | NAME<br>BHASKAR<br>PK | SIGN<br>Sd/-                      | DATE<br>OCT 2019         |
|                                                                                                            |                                                                                         |                                                                                                                                            |                | APPD                                                                                  | GB                    | Sd/-                              | OCT 2019                 |
|                                                                                                            | TITLE<br>CRANE CLEARANCE DIAGRAM OF 10T EOT CRANE<br>WORKSHOP BUILDING                  |                                                                                                                                            |                |                                                                                       |                       |                                   |                          |
|                                                                                                            |                                                                                         |                                                                                                                                            | DEPT.          | SCALE                                                                                 | NTS                   | DRAWING NO.<br>PE-DG-435-501-A007 |                          |
|                                                                                                            |                                                                                         | SIGN                                                                                                                                       | DATE           |  |                       | SHEET 1                           | Page 83 of 208<br>Rev. 0 |



**TECHNICAL SPECIFICATION**  
**FOR**  
**2x660 MW UDANGUDI TPP-STAGE I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T)**

**SECTION-I**

**SUB-SECTION-IB**

**REV. 00**

**DATE: MAR 2020**

**SUB SECTION-IB**

**SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)**

**TAMILNADU GENERATION &  
DISTRIBUTION CORPORATION LTD.**

**2 X 660 MW UDANGUDI STPP STAGE-I**

**DOUBLE GIRDER EOT CRANE**

**TECHNICAL SPECIFICATION  
(ELECTRICAL PORTION)**



|                                                                                                                        |                                      |
|------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| TITLE:<br><b>ELECTRICAL EQUIPMENT SPECIFICATION<br/>FOR<br/>DG EOT CRANE<br/><br/>2 X 660 MW UDANGUDI STPP STAGE-I</b> | SPECIFICATION NO.                    |
|                                                                                                                        | VOLUME NO. : <b>II-B</b>             |
|                                                                                                                        | SECTION: <b>C</b>                    |
|                                                                                                                        | REV NO. : <b>00</b> DATE: 04/07/2018 |
|                                                                                                                        | SHEET: OF                            |

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| SECTION | TITLE                                        | NO OF SHEETS |
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| C       | TECHNICAL SPECIFICATION FOR MOTORS/ACUATORS  | 12           |
| C       | MOTOR DATA SHEET – A                         | 4            |
| D       | STANDARD TECHNICAL SPECIFICATION – LV MOTORS | 5            |
| D       | MOTOR DATA SHEET-C                           | 2            |
| D       | QUALITY PLAN (FOR MOTORS ABOVE & 55 KW)      | 9            |
| D       | SUBVENDOR LIST                               | 1            |
| D       | ELECTRICAL LOAD DATA FORMAT (ANNEX-II)       | 1            |
| D       | CABLE SCHEDULE FORMAT INCLUDING NOTES        | 3            |

|                                                                                  |                                                                                                                                    |                                      |
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|  | <b>TITLE:</b><br><b>ELECTRICAL EQUIPMENT SPECIFICATION<br/>FOR<br/>DG EOT CRANE</b><br><br><b>2 X 660 MW UDANGUDI STPP STAGE-I</b> | SPECIFICATION NO.                    |
|                                                                                  |                                                                                                                                    | VOLUME NO. : <b>II-B</b>             |
|                                                                                  |                                                                                                                                    | SECTION: <b>C</b>                    |
|                                                                                  |                                                                                                                                    | REV NO. : <b>00</b> DATE: 04/07/2018 |
|                                                                                  |                                                                                                                                    | SHEET: <b>OF</b>                     |

#### **SPECIFIC TECHNICAL REQUIREMENTS:**

##### **1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:**

The equipment and services to be provided by bidder under this specification shall be as detailed here below but shall not be limited to the following:

- a) Services and Equipment as per "Electrical Scope between BHEL and Vendor".
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work 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.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for DG EOT CRANE.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer / BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings including GA drg, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc. shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.
- h) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.
- i) Motors shall meet minimum requirement of Electric motor specification.
- j) Purchaser will furnish data sheets to the vendor after award of contract. Vendor shall furnish filled in data sheets meeting the specification requirements.
- k) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- l) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

##### **2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:**

Refer "Electrical Scope between BHEL and Vendor".

##### **3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID**



|                                                                                                                        |                                      |
|------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| TITLE:<br><b>ELECTRICAL EQUIPMENT SPECIFICATION<br/>FOR<br/>DG EOT CRANE<br/><br/>2 X 660 MW UDANGUDI STPP STAGE-I</b> | SPECIFICATION NO.                    |
|                                                                                                                        | VOLUME NO. : <b>II-B</b>             |
|                                                                                                                        | SECTION: <b>C</b>                    |
|                                                                                                                        | REV NO. : <b>00</b> DATE: 04/07/2018 |
|                                                                                                                        | SHEET: <b>OF</b>                     |

- 3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical / quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:
- A copy of this sheet "Electrical Equipment Specification for DG EOT CRANE and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
  - Electrical load requirement.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.
- 4.0 **LIST OF ENCLOSURES**
- Electrical scope between BHEL & vendor
  - Technical specification – Specification for Electric Motors/Actuators
  - Standard Technical specification – LV Motors
  - Datasheets & quality plan for motors.
  - Load Data Format. (Annexure –II)
  - BHEL Cable listing format (Annexure –III)

## STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: DOUBLE GIRDER EOT CRANES

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

PROJECT :

| <u>S.NO</u> | <u>DETAILS</u>                                                                                                                   | <u>SCOPE<br/>SUPPLY</u> | <u>SCOPE E&amp;C</u> | <u>REMARKS</u>                                                                                                                                                                                                                  |
|-------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | Isolating Switch                                                                                                                 | Vendor                  | Vendor               | BHEL will provide one number 415 V(3ph, 3W) supply feeder only up to isolating switches for cranes. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel. |
| 2           | Power cables, control cables, screened control cables and any special cables (if required) between equipment supplied by vendor. | Vendor                  | Vendor               | Cable from supply feeder to isolating switch shall be in BHEL scope.                                                                                                                                                            |
| 3           | Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).                                         | Vendor                  | Vendor               |                                                                                                                                                                                                                                 |
| 4           | Equipment Earthing                                                                                                               | Vendor                  | Vendor               | All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL.                                                                |
| 5           | Motors                                                                                                                           | Vendor                  | Vendor               |                                                                                                                                                                                                                                 |
| 6           | Cable glands and lugs for equipment supplied by vendor                                                                           | Vendor                  | Vendor               | 1. Double compression Ni-Cr plated brass cable glands<br>2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.                                                                                 |
| 7           | Electrical Equipment GA drawing                                                                                                  | Vendor                  | -                    | For necessary interface review.                                                                                                                                                                                                 |



## SECTION-3.16: MOTORS

### 1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT motors, LT Motors and DC motors.

### 2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

- |                 |                                                                                                            |
|-----------------|------------------------------------------------------------------------------------------------------------|
| a) IS: 325      | Three phase induction motors                                                                               |
| b) IS: 12615    | Energy efficient induction motors                                                                          |
| c) IS: 900      | Code of practice for installation and maintenance of induction motors                                      |
| d) IS: 996      | Single-phase AC induction motor for general purpose                                                        |
| e) IS: 1231     | Dimensions of three-phase foot-mounted induction motors                                                    |
| f) IS: 2223     | Dimensions of flange mounted AC induction motors                                                           |
| g) IS: 4029     | Guide for testing three-phase induction motors                                                             |
| h) IS: 8789     | Values of performance characteristics for three-phase induction motors                                     |
| i) IS: 13555    | Guide for selection and application of 3-phase AC induction motors for different types of driven equipment |
| j) IS: 5571     | Guide for selection of electrical equipment for hazardous areas                                            |
| k) IS: 12065    | Permissible limits of noise level for rotating electrical machines                                         |
| l) IS: 12075    | Mechanical vibration of rotating electrical machines                                                       |
| m) IS 60034-5   | Degree of protection provided by Integral design of rotating electrical machines                           |
| n) IS 60034-8   | Terminal marking and direction of rotation                                                                 |
| o) IS 60079-1   | Equipment protection by flame proof enclosure                                                              |
| p) IS 60034-1   | Rotating electrical machines.                                                                              |
| q) IS 60079     | Explosive atmospheres                                                                                      |
| r) IS/IEC 60529 | Degrees of protection provided by enclosures (IP code)                                                     |
| s) IEC 60034    | Rotating electrical machines.                                                                              |
| t) IS 3177      | Code of practice for Design, Manufacture, Erection and testing of Cranes and Hoists                        |

### 3.0.0 TECHNICAL REQUIREMENTS

#### 3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

#### 3.2.0 Supply voltage

Motors rated up to and including 415 V are termed as LT motors and the motors rated higher than 415 V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.



- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : ( $\pm$ ) 10%
- Voltage variation for HT motors : ( $\pm$ ) 6%
- Combined variation of voltage and frequency : 10% (absolute sum)

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

### 3.3.0 System Parameters

| Sl. No. | Description                                                     | 11 kV and 6.6 kV System                                              | LT System                                                |
|---------|-----------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------|
| 1.      | Voltage level                                                   | 6.6 kV : Above 200 kW and upto 2000 kW<br><br>11 kV: Above 2000 kW   | 240 V : up to 0.2 kW<br>415 V: >0.2 kW and up to 200 kW. |
| 2.      | System earthing                                                 | Earthed through resistance, limiting earth fault current to 300 Amps | 415 V system solidly grounded.                           |
| 3.      | Fault withstand rating of motor terminal box (Breaker operated) | 50 kA for 0.2 sec for 11 kV and 31.5 kA for 0.2 sec for 6.6 kV       | 415 V system : 50/65 kA for 0.2 second                   |

### 3.4.0 Type

AC Motors shall be squirrel cage induction type unless otherwise it is specified.

### 3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty.
- DC motor shall generally be of shunt wound type rated for 220 V DC.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.
- The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.

### 3.6.0 Design margin

Whenever the basis for motor rating are not specified in the corresponding mechanical specification section maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.

Service shall be considered as 1.0 only.



### 3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load. Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.
- LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.
- HT Motors shall be controlled through vacuum circuit breaker.

### 3.8.0 Efficiency

All the duty motors shall be energy efficient type. For HT and LT motors, it shall be IE3 class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.

### 3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of air cooled motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.
- Temperature rise of water cooled motors shall not exceed 80°C over inlet cooling water temperature by resistance method, while delivering its maximum rated output.

### 3.10.0 Starting voltage

- a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on-line starting, without exceeding specified winding temperatures.
  - HT Motors (up to 1000 kW) : 85% of rated voltage
  - HT Motors (> 1000 kW up to 4000 kW) : 80% of rated voltage
  - HT Motors (> 4000 kW) : 75% of rated voltage
  - LT motors : 80% of rated voltage
- b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.
- c) The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes.

### 3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).

**3.12.0 Starting current**

- Locked rotor current of HT motors for applications other than listed below shall be limited to 600% of the full load current, and is subject to IS tolerance.
- For energy efficient LT motors, locked rotor current shall be as per IS: 12615.
- 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.
- Locked rotor current of the BFP motors shall be limited to 450% of the full load current of the motor, and is subject to IS tolerance.

**3.13.0 Locked rotor withstand time**

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible. In case the speed switch is required, it shall be indicated by the bidder in his offer
- For the LT motors having starting time up to 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, 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.
- Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation.

**3.14.0 Torque Requirements**

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.

**3.15.0 Enclosure**

- a) Motors shall have IP 55 degree of protection.
- b) For hazardous location, the enclosure of motors shall following have flame proof construction conforming to applicable standard.
  - Fuel oil area Group – IIB
  - Hydrogen generation plant area : Group – IIC)



### 3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA-IC6A1A1) type.
- Motors rated >3000 kW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
  - Hot and cold air temperatures of the closed air circuit for CACA motors.
  - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

### 3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- 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.
- Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 600034-15.
- For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.

### 3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.



- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- For motors rated above 1000 KW having shaft length more than 1.5 M shall have insulated bearings to prevent flow of shaft currents.
- All the motors rated <15 kW shall be provided with sealed ZZ bearings.
- Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.

### 3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of HT motors shall be capable of being turned 360° in steps of 180°. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.2 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.
- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fiber glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motors rated >1000 kW shall be provided with neutral current transformers of PS class on each phase for differential protection in neutral side terminal box. The three phases shall be connected to form the star point after passing through the CTs. The CT details shall be



finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.

- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

### 3.20.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.

### 3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

### 3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

In addition to the minimum information required by IEC/IS, the following information shall be shown on motor rating plate:

- Temperature rise in °C under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

### 3.23.0 Canopy

Canopy shall be provided for all the motors located outdoor. For details, please refer Civil section.

## 4.0.0 DC MOTORS

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.

## 5.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

## 6.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and



outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).

#### 7.0.0 TESTING AND INSPECTION

7.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished for the motors rated 30 kW and above.

7.2.0 The following type tests shall be conducted on LT motors.

- Measurement of resistance of windings of stator and wound rotor.
- No load test at rated voltage to determine input current power and speed
- Full load test to determine efficiency power factor and slip.
- Temperature rise test.
- Momentary excess torque test.
- High voltage test.
- Test for vibration severity of motor.
- Test for noise levels of motor
- Test for degree of protection
- Over speed test.

7.3.0 The following additional type tests shall be conducted on HT motors.

- No load saturation and loss curves up to approximately 115% of rated voltage
- Measurement of noise at no load.
- Momentary excess torque test
- Full load test
- Temperature rise test at rated conditions.
- Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15
- Surge-withstand test on interturn insulation shall be as per clause no. 5.1.2 of IEC 60034, part-15
- Degree of protection test for the enclosure followed by IR, HV and no load run test.
- Terminal box-fault level withstand test for each type of terminal box.

7.4.0 The following routine tests shall be carried out for the motors as per applicable standards.

- IR of Winding before and after HV tests
- HV test on main winding space heater, RTD, BTD
- Resistance measurement
- No load run test Major Electrical
- Phase sequence and direction of rotation
- Vibration check Major Electrical
- Reduced voltage running test
- Locked rotor test at reduced voltage
- Record of RTD & BTD resistance at the end of no load test
- Test on space heater & RTD
- Visual Control of terminal box and verification of construction with respect to short tested terminal box

7.5.0 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out

- Measurement of vibration.
- Measurement of insulation resistance and polarization index.
- Measurement of full load current.
- Test running of the motors, checking the temperature rise and identifying the hot spot etc.



### 8.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Motor sizing calculation
- Technical particulars
- General arrangement drawings
- Performance curves (Efficiency, power factor, starting current)
- Characteristic curves (Speed torque, Hot/cold with stand time, Negative sequence current)
- Terminal box details
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan



## SECTION-3.17: ELECTRICAL ACTUATORS

### 1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical actuators.

### 2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the applicable Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

### 3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Electric actuators shall be provided as specified in Mechanical and C&I section. It shall be equipped with 3 phase induction motor, rated for S2-15 minutes duty for ON/OFF valve and intermittent duty for inching duty

3.2.0 Motor shall be class F insulated with temperature rise limited to class B. Motor shall be of class H insulation with temperature limited to class B used for high pressure and high temperature valves.

3.3.0 Motor shall be surface cooled designed for enclosure protection class of IP 67. Motor shall be suitable for starting direct on-line.

3.4.0 For installation in potentially hazardous areas, the actuators shall have suitable explosion proof / flame proof type enclosure.

3.5.0 Actuators shall be suitable for operation at an ambient temperature of 50 degree C and relative humidity of 95%.

3.6.0 Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

3.7.0 Motors shall be capable of operating under following supply variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5% of 50 Hz
- Voltage variation for LT motors : (±) 10% of 415 V
- Combined variation of voltage and frequency: 10% (absolute sum)

3.8.0 All actuators shall be of integral type. Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust.

3.9.0 Electrical Actuators of Inching type position transmitters of non contact type shall be interfaced to DCS.

3.10.0 Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 65 enclosure and shall be suitable for outdoor application without the necessity for a canopy. The actuator shall be suitable for mounting directly on the valve. The actuator shall be capable of giving the required torque, rpm and thrust without the help of any spur gear arrangement. The actuator shall be suitable for mounting in any position. Actuators shall be provided with integral starters.



- 3.11.0 The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.
- 3.12.0 Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.
- 3.13.0 Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.
- 3.14.0 Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weather proof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 240 Volts AC, 10 A and 220 V DC, 0.5 Amps.
- 3.15.0 Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply.
- 3.16.0 The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.
- 3.17.0 Actuators shall be supplied with 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..
- 3.18.0 A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.
- 3.19.0 The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.
- 3.20.0 The following individual sStatus annunciation LED's and fault annunciation LED's 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
- 3.21.0 The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)



- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

3.22.0 View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.

3.23.0 Electronic Overload relay shall be provided to trip actuator in case of overload.  
Plug in connections/design shall be provided between:-

- Integral starter unit and basic actuator
- Between external customer connections and actuator.

3.24.0 OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

3.25.0 Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

3.26.0 The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip

#### 4.0.0 TESTING AND INSPECTION

Equipment offered shall be of type tested and proven type. Routine tests shall be carried out for all the equipment as per applicable standards. Copies of certified reports of all tests carried out at the works shall be furnished.

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors.

#### 5.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Integral starter details
- Technical particulars of actuator
- Wiring diagram
- General arrangement drawings
- Test reports
- Manufacturing quality plan
- Field quality plan



## SECTION - 3.24: CABLES

### 1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cables.

### 2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) 19/33 kV grade XLPE insulated armoured FRLS power cables
- b) 11/11 kV grade XLPE insulated armoured FRLS power cables
- c) 6.6/6.6 kV grade XLPE insulated armoured FRLS cables
- d) 1.1 kV grade XLPE insulated armoured FRLS cables
- e) 1.1 kV grade XLPE insulated armoured FRLS control cables
- f) Trailing cables
- g) Shielded cables
- h) Telephone cables
- i) Fiber optic cables

### 3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and / or supplemented by this specification.

- |                     |                                                                  |
|---------------------|------------------------------------------------------------------|
| a) IS: 3975         | Mild steel wires formed wires and tapes for armouring of cables. |
| b) IS: 4905         | Methods for random sampling.                                     |
| c) IS: 5831         | PVC insulation and sheath of electric cables.                    |
| d) IS: 7098 Part-I  | Cross-linked polyethylene insulated PVC sheathed cables (LV)     |
| e) IS: 7098 Part-II | Cross-linked polyethylene insulated PVC sheathed cables (HV)     |
| f) IS: 8130         | Conductors for insulated electric cables and flexible cords.     |
| g) IS: 10418        | Drums for electric cables.                                       |
| h) IS: 10810        | Methods of tests for cables.                                     |
| i) IS: 3961         | Recommended current ratings for cables                           |

### 4.0.0 TECHNICAL REQUIREMENTS

#### 4.1.0 Power cables shall be provided for the following systems:

- 33 kV earthed system having phase fault current and earth fault current of 25 kA.
- 11 kV unearthed system having phase fault current of 50 kA and earth fault current of 300 A.
- 6.6 kV unearthed system having phase fault current of 31.5 kA and earth fault current of 300 A.
- 415 V earthed system having phase fault current and earth fault current of 65/50 kA.
- 220 V DC unearthed system having fault current of not less than 25 kA.

#### 4.2.0 Power cables shall be sized to withstand the system fault current for the fault clearing time indicated below:

- Breaker operated Motor feeders and transformer feeders: 0.16 second.
- Breaker operated outgoing feeders: 0.5 second.
- Tie between two switchgear: 0.5 second.
- Incomers: 1 second.



- 4.3.0 Power cables shall be sized to satisfy the following Criteria:
- To withstand specified system short circuit current for the specified fault clearing time.
  - To carry full load current under applicable installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
  - To limit the voltage drop under steady state/transient state conditions to permissible values.
- 4.4.0 Cables shall be armoured type only.
- 4.5.0 Power cables shall be XLPE insulated. Control cables shall be PVC / XLPE insulated.
- 4.6.0 PVC insulation shall be suitable for continuous conductor temperature of 70°C and short circuit conductor temperature of 160°C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.
- 4.7.0 Cables for 33 kV system shall be rated for 19/33 kV earthed grade, cables for 11 kV system shall be rated for 11/11 kV unearthed grade and Cables for 6.6 kV system shall be rated for 6.6/6.6 kV unearthed grade. Cables for 415/230 V AC and 220 V DC shall be rated for 1.1 kV grade.
- 4.8.0 To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have non-propagating, and self-extinguishing flame retardant, low smoke (FRLS) characteristics. Outer sheath shall be of PVC black in colour. These cables shall meet the following test requirements.
- Oxygen index of minimum 29 when tested as per IS 10810 Part-58
  - Temperature index of minimum 250°C when tested as per IS 10810 Part-64
  - Acid gas emission of maximum 20% when tested as per IS 10810 Part-59 Average light transmission of 40% minimum when tested as per IS 10810 Part-63 (average smoke density is maximum 60%)
  - Flame test requirements as per IS 10810 Parts-53 and 62
  - Flame retardant test requirements as per IS 10810 Part-61
- 4.9.0 For power cables, copper conductor shall be used for current rating of up to 10 A. For higher current rating, conductor can be aluminium/copper. Minimum size of copper conductor shall be 2.5 sq.mm and aluminium conductor shall be 6 sq.mm.
- 4.10.0 Conductor of control cables shall have plain annealed copper. The minimum size of control cable shall be of 1.5 sq.mm. For CT circuit minimum size shall be 2.5 sq.mm copper. Control cables shall have 20% spare cores.
- 4.11.0 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and knee point voltage. Minimum 2.5 sq.mm copper cables shall be used for connection of CT to load. In case 2.5 sq.mm size impose unacceptably high burden on CTs, 4 sq.mm copper shall be used. Voltage transformer leads shall be checked for voltage drop which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 2.5 sq.mm copper conductor exceeds this value, higher conductor sizes shall be used.
- 4.12.0 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.
- 4.13.0 Design ambient air temperature and ground temperature shall be considered at 50°C and 40°C respectively for cable sizing.
- 4.14.0 For 11 kV & 6.6 kV cables, screen of each core shall be sized to withstand 300 A for 1 sec. For 33 kV cables, screen of each core shall be sized to withstand system earth fault current for 0.16 sec.



- 4.15.0 For HT motors the voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 2.5% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 5% of rated voltage
- 4.16.0 For LT motors the voltage drop in the cable, during motor starting condition, shall be limited to 15% and during full load running condition, shall be limited to 3% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 6% of rated voltage.
- 4.17.0 Cables for the following systems shall be fire survival type.
- DC emergency lube oil pumps
  - DC seal oil pump
  - DC emergency lighting cables for main building.
  - Batteries to chargers and DC distribution boards
  - Turbine lub oil pumps
  - Jacking oil pumps
  - Emergency turbine trip by push button in control room
  - Inter trip cables between Boiler master fuel trip and turbine trip relays
  - Inter trip cables between Generator trip relays and turbine trip relays/400 kV circuit breaker/generator field breaker/UT breakers
- 4.18.0 Method of curing for HT XLPE insulation shall be **gas/steam curing**.
- 4.19.0 Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.
- 4.20.0 For armoured cables, armouring shall be of aluminium for single core cables. For multicore armoured cables, armouring shall be of galvanised steel.
- 4.21.0 All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.
- 4.22.0 Multi-core cable color coding shall be as follows:
- Red, yellow, blue, black and gray for five core cables
  - Outer sheath shall be of black in colour.
  - For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
- 4.23.0 Three core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:
- Circular stranded and compacted aluminium conductor
  - Extruded semi conducting compound as conductor screen
  - Extruded XLPE insulation
  - Extruded semi conducting compound as insulation screen
  - Copper tape as metallic screen for each core
  - Extruded PVC inner sheath
  - Galvanised steel formed wire/strip
  - Extruded FRLS PVC outer sheath
- 4.24.0 Single core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:
- Circular stranded and compacted aluminium conductor
  - Extruded Semi conducting compound as conductor screen
  - Extruded XLPE insulation
  - Extruded Semi conducting compound as insulation screen
  - Copper tape as metallic screen
  - Hard drawn aluminium wire armour
  - Extruded FRLS PVC outer sheath



4.25.0 Multicore 1.1 kV earthed grade cables shall constitute the following:

- Circular / shaped, stranded aluminium conductor (compacted for >10 sq.mm)
- Extruded XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.26.0 Single core 1.1 kV earthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded XLPE insulation
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

4.27.0 **Trailing power and control cables for mobile equipment shall constitute the following:**

Unearthed grade HT power cables, earthed grade LV power cables and control cables shall be flexible trailing with annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed. For HT cables, insulation screen shall be provided. Cables shall conform to applicable IS/IEC standard requirements.

4.28.0 **Fire survival cables**

Fire survival cable shall be of copper conductor and comply with IEC-60331 (withstanding 750 degree C temperature for 3 hours). Also the halogen acid contents in outer sheath shall not be more than 2% when tested as per IEC-60754 and the smoke density in percent light absorption shall not exceed 20% when tested as per ASTM-D-2843. 1.1 kV earthed grade fire survival cables shall constitute the following:

- Circular/shaped stranded and compacted annealed copper conductor
- Elastomeric materials (XLPE, EPR, SR, or LSOH) insulated
- Glass mica taped
- Extruded FRLS compound or LSOH material as inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS compound or LSOH material as inner sheath

4.29.0 Multicore 1.1 kV earthed grade control cables shall constitute the following as per IS:1554-1 / 7098-1:

- Multi stranded annealed copper conductor
- Extruded PVC / XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.30.0 Multi pair 1.1 kV earthed grade, overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.31.0 Multi pair 1.1 kV earthed grade, individual and overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair



- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

#### 4.32.0 Cable drums

Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. All wooden parts shall be manufactured from durable quality wood duly seasoned and treated with copper nepthenates or zinc nepthenates for preserving the wood. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

#### 4.33.0 Cable identification system

- a) In addition to manufacturer's identification on cables as per IS, following marking shall also be embossed/printed on the outer sheath at an interval of one metre throughout the length of cables.
  - BIS mark
  - Manufacturer's name and or trade mark.
  - Year of manufacture
  - Cable code
  - Type of cable and voltage class.
  - Nominal cross section area of conductor and no.of cores.
  - Progressive sequential length making.
- b) Cables shall be marked as having FRLS outer sheath at every 5 meters.
- c) The embossing/printing shall be progressive, automatic, in line and marking shall be legible and indelible.
- d) Multi-core cable color coding shall be as follows:
  - Red, yellow and blue for three core cables
  - Outer sheath shall be of black in colour.
  - For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
  - For multi pair cables, each pair shall be coloured and numbered.

#### 5.0.0 TESTS

Cables offered shall be type tested and proven type. Routine tests shall be carried out on 100% drums. Type tests, special tests and acceptance tests shall be carried out on 1 drum selected on random basis, out of every 10 or less number of drums of each type and size of cable of each lot. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc.

#### 5.1.0 Type Test

- a) Tests on conductor



- i) Annealing Test (for copper)
- ii) Tensile test (for aluminium)
- iii) Wrapping test (for aluminium)
- iv) Resistance test
  
- b) Tests for armour wires/strips
- c) Tests for thickness of insulation and sheath
- d) Physical tests for insulation
  - i) Tensile strength and elongation at break
  - ii) Ageing in air oven
  - iii) Shrinkage test
  - iv) Hot test
  - v) Water absorption (gravimetric)
- e) Physical test for outer sheath
  - i) Tensile strength and elongation at break
  - ii) Ageing in air oven
  - iii) Shrinkage test
  - iv) Hot deformation
  - v) Heat shock test
  - vi) Loss of mass test in air oven
  - vii) Thermal heat stability test (as per IS : 5831)
  - viii) Bleeding and blooming test
- f) Anti-termite and anti-rodent test (on outer sheath).
- g) Partial discharge test
- h) Bending test
- i) Dielectric power factor test
  - i) As a function of voltage
  - ii) As a function of temperature
- j) Insulation resistance (volume resistivity) test
- k) Heating cycle test
- l) Impulse withstand test
- m) High voltage test
- n) Flammability test
- o) Cold impact test

#### 5.2.0 Acceptance Test

- a) Annealing test (for copper)
- b) Tensile test (for aluminium)
- c) Wrapping test (for aluminium)
- d) Conductor resistance test
- e) Test for thickness of insulation and sheath
- f) Hot set test for insulation
- g) Tensile strength and elongation at break test for insulation and outer sheath
- h) Partial discharge test (for screened cables)
- i) High voltage test
- j) Insulation resistance (volume resistivity) test

#### 5.3.0 Routine Test

- a) Conductor resistance test
- b) Partial discharge test



- c) High voltage test

#### 5.4.0 Special Test

- a) Oxygen index test as per IS 10810 Part-58
- b) Temperature index test as per IS 10810 Part-64
- c) Acid gas generation test as per IS 10810 Part-59
- d) Smoke generation test as per IS 10810 Part-63
- e) Flammability tests as per IS 10810 Parts-53 and 62
- f) Flame retardant test as per IS 10810 Part-61

#### 5.5.0 Site Test

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- a) Insulation resistance test
- b) High voltage test

#### 6.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted 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-A |                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SL NO.       | DESCRIPTION                                                | 2X660 MW UDANGUDI SUPERCRITICAL<br>STPP                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>A</b>     | <b>General</b>                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1            | Manufacturer & country of origin                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 2            | Motor type                                                 | Squirrel cage induction AC motors                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 3            | Efficiency class                                           | For all LT motors, it shall be IE3 class as per IS 12615 except for VFD controlled LT motors, it shall be IE2 class as per IS 12615                                                                                                                                                                                                                                                                                                                                           |
| 4            | Type of starting                                           | DOL                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5            | Maximum acceptable kW rating of LV motor                   | >0.2 kW and up to 200 kW.<br>LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.                                                                                                                                                                                                                                                                              |
| 6            | Rating up to which Single phase motors permitted.          | up to 0.2 Kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 7            | Installation (Indoors/ Outdoors)                           | indoor/outdoor                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8            | Degree Of Protection                                       | IP 55                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 9            | Name of the equipment driven by motor & Quantity           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 10           | Maximum Power requirement of driven equipment              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 11           | Rated speed of Driven Equipment                            | As per system requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 12           | Design ambient temperature                                 | 50 deg C                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>B</b>     | <b>Design and Performance Data</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1            | Frame size & type designation                              | DURING DETAILED ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2            | Type of duty                                               | All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty.<br><br>The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.                                                                                                                                                                                       |
| 3            | Rated Voltage                                              | 240/415 V                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 4            | Rated Frequency                                            | 50 Hz                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 5            | System fault level at rated voltage                        | 50 kA for 1 sec.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6            | LV System grounding                                        | solidly grounded                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 7            | Permissible variation for                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| a            | Voltage                                                    | ±10%                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| b            | Frequency                                                  | +3% to -5%                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| c            | Combined voltage & frequency                               | 10%                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 8            | Rated output at design ambient temp (by resistance method) | As per system requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 9            | Synchronous speed & Rated slip                             | As per system requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 10           | Minimum permissible starting voltage                       | 80% of rated voltage<br><br>During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.<br>c) The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes. |

|          |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11       | TYPE OF STARTER PROVIDED IN MCC                                    | DOL                                                                                                                                                                                                                                                                                                                                                                                                               |
| 12       | Starting time in sec with mechanism coupled                        |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| a        | At rated voltage                                                   | As per manufacturers standard                                                                                                                                                                                                                                                                                                                                                                                     |
| b        | At min starting voltage                                            |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 13       | Locked rotor current as percentage of FLC (including IS tolerance) | For energy efficient LT motors, locked rotor current shall be as per IS: 12615.<br><br>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       | Torque                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| a        | Starting                                                           | Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.<br>• Pull out torque at rated voltage shall not be less than 205% of full load torque.<br>• Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction. |
| b        | Maximum                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 15       | Permissible temp rise at rated output over ambient temp & method   | Winding shall be class F insulation with temperature limited to class B                                                                                                                                                                                                                                                                                                                                           |
| 16       | Noise level at 1.0 m (dB)                                          | Motors shall be selected with low noise levels in accordance with IS 12065.                                                                                                                                                                                                                                                                                                                                       |
| 17       | Amplitude of vibration                                             | The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.                                                                                                                                                                                                                                                                                                                       |
| 18       | Efficiency & P.F. at rated voltage & frequency                     |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| a        | At 100% load                                                       | Premium efficiency (IE3) IS: 12615 .                                                                                                                                                                                                                                                                                                                                                                              |
| b        | At 75% load                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| c        | At starting                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>C</b> | <b>Constructional Features</b>                                     |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 1        | Method of connection of motor driven equipment                     | As per system requirement                                                                                                                                                                                                                                                                                                                                                                                         |
| 2        | Applicable Standard                                                | as per relevant standard                                                                                                                                                                                                                                                                                                                                                                                          |
| 3        | DOP of Enclosure                                                   | IP55                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4        | Method of cooling                                                  | LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.<br><br>The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.                                                                                                                                            |
| 5        | Class of insulation                                                | All motors shall have class F insulation but limited to class B temperature rise                                                                                                                                                                                                                                                                                                                                  |
| 6        | Main terminal box                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                   |

|    |                                                        |                                                                                                                                                                                                                                                                                                                                                      |
|----|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a  | Type                                                   | <p>Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material.</p> <p>Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.</p> |
| b  | Power Cable details (Conductor, size, armour/unarmour) | DURING DETAILED ENGINEERING                                                                                                                                                                                                                                                                                                                          |
| c  | Cable Gland & lugs details (Size, type & material)     | <p>DURING DETAILED ENGINEERING</p> <p>The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.</p>                                                                                                         |
| d  | Permissible Fault level ( kArms & duration in sec)     | Fault withstand rating of motor terminal box (Breaker operated): 415 V system : 50/65 kA for 0.2 second                                                                                                                                                                                                                                              |
| 7  | Earth Conductor Size & Material                        | DURING DETAILED ENGINEERING                                                                                                                                                                                                                                                                                                                          |
| 8  | Space heater details (30KW & ABOVE) (Voltage & watts)  | Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW'and above to maintain windings in dry condition when motor is standstill.                                                                                                                                                                                    |
| 9  | Flame proof motor details (if applicable)              | <p>For hazardous location: the enclosure of motors shall following have flame proof construction conforming to applicable standard.</p> <ul style="list-style-type: none"> <li>• Fuel oil area Group – IIB</li> <li>• Hydrogen generation plant area : Group – IIC)</li> </ul>                                                                       |
| a  | Enclosure                                              |                                                                                                                                                                                                                                                                                                                                                      |
| b  | suitability for hazardous area                         |                                                                                                                                                                                                                                                                                                                                                      |
| i  | Zone O / I / II                                        |                                                                                                                                                                                                                                                                                                                                                      |
| ii | Group IIA / IIB / IIC                                  |                                                                                                                                                                                                                                                                                                                                                      |
| c  | Degree of Protection                                   |                                                                                                                                                                                                                                                                                                                                                      |
| 9  | No. of Stator winding                                  | As per manufacturers standard                                                                                                                                                                                                                                                                                                                        |
| 10 | Winding connection                                     | As per system requirement                                                                                                                                                                                                                                                                                                                            |
| 11 | Kind of rotor winding                                  | As per manufacturers standard                                                                                                                                                                                                                                                                                                                        |

|          |                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12       | Kind of bearings                                         | <p>Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.</p> <ul style="list-style-type: none"> <li>• Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for inservice positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself.</li> <li>• Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.</li> <li>• Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided.</li> </ul> <p>For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.</p> <ul style="list-style-type: none"> <li>• Each bearing shall be provided with dial type thermometer.</li> <li>• For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.</li> </ul> <p>Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.</p> |
| 13       | Direction of rotation when viewed from NDE               | motor shall be bi-directional                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 14       | Paint Shade & type                                       | Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 15       | Net weight of motor                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 16       | Outline mounting drawing No (To be enclosed as annexure) | DURING DETAILED ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>D</b> | <b>Characteristic curves/ drawings</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1        | (To be enclosed for motors of rating >55KW)              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2        | Torque speed characteristic                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3        | Thermal withstand characteristic                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 4        | Current vs time                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5        | Speed vs time                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>E</b> | <b>Tests on motors</b>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

**NOTE:**

- 1 Please write "As per manufacturers standard" where data is not defined in the project specification.
- 2 Please mention any project specific requirement if any in the datasheet (Add extra row).
- 3 For details which is not applicable please write "NA"



TITLE :  
**GENERAL TECHNICAL REQUIREMENTs**  
  
**FOR**  
  
**LV MOTORS**

SPECIFICATION NO.  
PE-SS-999-506-E101  
VOLUME NO. : **II-B**  
SECTION : **D**  
REV NO. : **00** DATE : 29/08/2005  
SHEET : 1 OF 1

**GENERAL TECHNICAL REQUIREMENTS**

**FOR**

**LV MOTORS**

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



**TITLE :**  
**GENERAL TECHNICAL REQUIREMENTS**  
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**PE-SS-999-506-E101**  
**VOLUME NO. : II-B**  
**SECTION : D**  
**REV NO. : 00 DATE : 29/08/2005**  
**SHEET : 1 OF 4**

**1.0 INTENT OF SPECIFICATION**

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

**2.0 CODES AND STANDARDS**

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

|           |                                                                                                              |
|-----------|--------------------------------------------------------------------------------------------------------------|
| IS:325    | Three phase Induction motors                                                                                 |
| IS : 900  | Code of practice for installation and maintenance of induction motors                                        |
| IS: 996   | Single phase small AC and universal motors                                                                   |
| IS: 4722  | Rotating Electrical machines                                                                                 |
| IS: 4691  | Degree of Protection provided by enclosures for rotating electrical machines                                 |
| IS: 4728  | Terminal marking and direction of rotation rotating electrical machines                                      |
| IS: 1231  | Dimensions of three phase foot mounted induction motors                                                      |
| IS: 8789  | Values of performance characteristics for three phase induction motors                                       |
| IS: 13555 | Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment |
| IS: 2148  | Flame proof enclosures for electrical appliance                                                              |
| IS: 5571  | Guide for selection of electrical equipment for hazardous areas                                              |
| IS: 12824 | Type of duty and classes of rating assigned                                                                  |
| IS: 12802 | Temperature rise measurement for rotating electrical machines                                                |
| IS: 12065 | Permissible limits of noise level for rotating electrical machines                                           |
| IS: 12075 | Mechanical vibration of rotating electrical machines                                                         |

In case of imported motors, motors as per IEC-34 shall also be acceptable.

**3.0 DESIGN REQUIREMENTS**

**3.1** Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

**3.2** Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information  
 Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

**3.3 Starting Requirements**

**3.3.1** Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

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



TITLE :  
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The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

- i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.
- ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)
- iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

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

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

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

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

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

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

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

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

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

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            |                                         |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TITLE :<br><b>GENERAL TECHNICAL REQUIREMENTS</b><br><br><b>FOR</b><br><br><b>LV MOTORS</b> | SPECIFICATION NO.<br>PE-SS-999-506-E101 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            | VOLUME NO. : <b>II-B</b>                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            | SECTION : <b>D</b>                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            | REV NO. : <b>00</b> DATE : 29/08/2005   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                            | SHEET : 3 OF 4                          |
| <p>4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.</p> <p>4.5. Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.</p> <p>4.6. In case Class ‘F’ insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class ‘B’ insulation.<br/>In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.</p> <p>4.7 <b>Terminals and Terminal Boxes</b></p> <p>4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.</p> <p>Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet “A”.</p> <p>4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.</p> <p>4.7.3 Connections shall be such that when the supply leads R, Y &amp; B are connected to motor terminals A B &amp; C or U, V &amp; W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W &amp; V respectively.</p> <p>4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.</p> <p>4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.</p> <p>4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.</p> <p>4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.</p> <p>4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.</p> <p>4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.</p> <p>4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.</p> <p>4.9 <b>General</b></p> |                                                                                            |                                         |

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|                                                                                  |                                                                                            |                                         |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------------|
|  | TITLE :<br><b>GENERAL TECHNICAL REQUIREMENTS</b><br><br><b>FOR</b><br><br><b>LV MOTORS</b> | SPECIFICATION NO.<br>PE-SS-999-506-E101 |
|                                                                                  |                                                                                            | VOLUME NO. : <b>II-B</b>                |
|                                                                                  |                                                                                            | SECTION : <b>D</b>                      |
|                                                                                  |                                                                                            | REV NO. : <b>00</b> DATE : 29/08/2005   |
|                                                                                  |                                                                                            | SHEET : 4 OF 4                          |

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

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

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 **INSPECTION AND TESTING**

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

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

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

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 **DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

a) OGA drawing showing the position of terminal boxes, earthing connections etc.

b) Arrangement drawing of terminal boxes.

c) Characteristic curves:  
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).

i) Current vs. time at rated voltage and minimum starting voltage.

ii) Speed vs. time at rated voltage and minimum starting voltage.

iii) Torque vs. speed at rated voltage and minimum voltage.  
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.

iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

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|                                                                                   |                         |                          |
|-----------------------------------------------------------------------------------|-------------------------|--------------------------|
|  | TITLE                   | SPECIFICATION NO.        |
|                                                                                   | MOTORS                  | VOLUME II B              |
|                                                                                   | DATA SHEET – C          | SECTION D                |
|                                                                                   | 2 x 660MW UDANGUDI STPP | REV NO. 00 DATE 21.05.18 |
|                                                                                   |                         | SHEET 1 OF 2             |

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

|                |           |      |      |      |  |
|----------------|-----------|------|------|------|--|
| NAME OF VENDOR |           |      | SEAL | REV. |  |
|                |           |      |      |      |  |
| NAME           | SIGNATURE | DATE |      |      |  |

|                                                                                   |                                                                                               |                                        |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------|
|  | <b>TITLE</b><br><br><b>MOTORS</b><br><br><b>DATA SHEET – C</b><br><br>2 x 660MW UDANGUDI STPP | <b>SPECIFICATION NO.</b>               |
|                                                                                   |                                                                                               | <b>VOLUME</b> II B                     |
|                                                                                   |                                                                                               | <b>SECTION</b> D                       |
|                                                                                   |                                                                                               | <b>REV NO. 00</b> <b>DATE 21.05.18</b> |
|                                                                                   |                                                                                               | <b>SHEET</b> 2 <b>OF</b> 2             |

| S. No.    | Description                                                                                         | Data to be filled by successful bidder |
|-----------|-----------------------------------------------------------------------------------------------------|----------------------------------------|
|           | c) At starting                                                                                      |                                        |
| <b>C.</b> | <b>Constructional Features</b>                                                                      |                                        |
| 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)                                            |                                        |
| <b>D.</b> | <b>Characteristic curves/ drawings</b><br>(To be enclosed for motors of rating $\geq 55\text{KW}$ ) |                                        |
|           | a) Torque speed characteristic                                                                      |                                        |
|           | b) Thermal withstand characteristic                                                                 |                                        |
|           | c) Current vs time                                                                                  |                                        |
|           | d) Speed vs time                                                                                    |                                        |

|                |           |      |      |      |  |
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| NAME OF VENDOR |           |      | SEAL | REV. |  |
|                |           |      |      |      |  |
| NAME           | SIGNATURE | DATE |      |      |  |



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

| <div></div> |                                                                                    | QUALITY PLAN                                                                       |    | CUSTOMER :                                           |                                | PROJECT                                                   |                                 | SPECIFICATION :                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----|------------------------------------------------------|--------------------------------|-----------------------------------------------------------|---------------------------------|-----------------------------------------------|----|--------------------|----|-----------------|--|------------------|----|----------------|--|--------------------|--|
| SHEET 3 OF 9                                                                                   |                                                                                    | BIDDER/ VENDOR :                                                                   |    | BIDDER/ VENDOR :                                     |                                | QUALITY PLAN                                              |                                 | SPECIFICATION : TITLE                         |    |                    |    |                 |  |                  |    |                |  |                    |  |
| COMPONENT/OPERATION                                                                            |                                                                                    | CHARACTERISTIC CHECK                                                               |    | SYSTEM CAT.                                          |                                | TYPE/ METHOD OF CHECK                                     |                                 | EXTENT OF CHECK                               |    | REFERENCE DOCUMENT |    | ACCEPTANCE NORM |  | FORMAT OF RECORD |    | SECTION AGENCY |  | VOLUME III REMARKS |  |
| SL. NO.                                                                                        | 2                                                                                  | 3                                                                                  | 4  | 5                                                    | 6                              | 7                                                         | 8                               | 9                                             | 10 |                    | 11 |                 |  |                  |    |                |  |                    |  |
| 1                                                                                              |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
| 1.7                                                                                            | OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC. | 1. SURFACE COND. ETC.<br><br>2. OTHER CHARACTERISTICS                              | MA | VISUAL                                               | 100%                           | -                                                         | NO VISUAL DEFECTS               | INSPT. REPORT                                 | 3  | -                  | 2  |                 |  |                  |    |                |  |                    |  |
| 1.8                                                                                            | SHEET STAMPING (PUNCHED)                                                           | 1. SURFACE COND.<br><br>2. DIMENSIONS INCLUDING BURS HEIGHT<br>3. ACCEPTANCE TESTS | MA | TEST<br><br>VISUAL                                   | SAMPLE<br><br>100%             | MANUF'S SPEC.                                             | MANUF'S SPEC.                   | LOG BOOK AND OR SUPPLIER'S TC<br><br>LOG BOOK | 3  | -                  | 2  |                 |  |                  |    |                |  |                    |  |
| 1.9                                                                                            | CONDUCTORS                                                                         | 1. SURFACE FINISH<br><br>2. ELECT. PROP. & MECH. PROP                              | MA | MEASUREMENT<br><br>ELECT. & MECH. TEST<br><br>VISUAL | SAMPLE<br><br>-DO-<br><br>100% | MANUF'S DRG. .<br><br>MANUF'S SPEC / RELEVANT IS<br><br>- | MANUF'S DRG.<br><br>RELEVANT IS | -DO-<br><br>SUPPLIER'S TC<br><br>LOG BOOK     | 3  | -                  | 2  |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               | 3* | -                  | 2* |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               | 3  | -                  | 2  |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
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|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  |    |                |  |                    |  |
|                                                                                                |                                                                                    |                                                                                    |    |                                                      |                                |                                                           |                                 |                                               |    |                    |    |                 |  |                  | </ |                |  |                    |  |

|  |                                    |                                                                                       |                          |                                               |                                | CUSTOMER :                                                  |                                                                                        | PROJECT                          |                  | SPECIFICATION :  |                |                    |   |
|-------------------------------------------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------|--------------------------|-----------------------------------------------|--------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------------------------|------------------|------------------|----------------|--------------------|---|
| QUALITY PLAN                                                                        |                                    |                                                                                       |                          |                                               |                                | BIDDER / VENDOR                                             |                                                                                        | TITLE                            |                  | NUMBER :         |                |                    |   |
| SHEET 4 OF 9                                                                        |                                    |                                                                                       |                          |                                               |                                | SYSTEM                                                      |                                                                                        | QUALITY PLAN                     |                  | TITLE            |                |                    |   |
| COMPONENT/OPERATION                                                                 |                                    | CHARACTERISTIC CHECK                                                                  |                          | CAT.                                          | TYPE/METHOD OF CHECK           | EXTENT OF CHECK                                             | REFERENCE DOCUMENT                                                                     | ACCEPTANCE NORM                  | FORMAT OF RECORD | SECTION          |                | VOLUME III REMARKS |   |
| SL. NO.                                                                             |                                    | 3                                                                                     | 4                        | 5                                             | 6                              | 7                                                           | 8                                                                                      | 9                                |                  |                  | P              | W                  | V |
| 1                                                                                   | 2                                  | 3                                                                                     | 4                        | 5                                             | 6                              | 7                                                           | 8                                                                                      | 9                                |                  |                  | 10 11          |                    |   |
| 1.10                                                                                | BEARINGS                           | 3.DIMENSIONS<br>1.MAKE & TYPE<br>2.DIMENSIONS                                         | MA<br><br>MA<br>MA       | MEASUREMENT<br>VISUAL<br>MEASUREMENT          | -DO-<br>100%<br>SAMPLE         | -DO-<br>MANUF'S DRG./ APPROVED DATASHEET<br>BHFL DATA SHEET | -DO-<br>MANUF'S DRG./ APPROVED DATASHEET<br>BHFL DATA SHEET BEARING MANUF'S CATALOGUES | -DO-<br>Log Book<br>-DO-<br>-DO- | 3<br>3<br>3      | -<br>-<br>-      | 2<br>2<br>2    |                    |   |
| 1.11                                                                                | SLIP RING<br>(WHEREVER APPLICABLE) | 3.SURFACE FINISH<br><br>1.SURFACE COND.<br>2.DIMENSIONS<br>3.TEMP.WITH-STAND CAPACITY | MA<br><br>MA<br>MA       | VISUAL<br>VISUAL<br>MEASUREMENT<br>ELECT.TEST | 100%<br>100%<br>SAMPLE<br>-DO- | -<br>-<br>MANUF'S DRG<br>MANUF'S SPEC./ BHFL SPEC.          | FREE FROM VISUAL DEFECTS<br>-DO-<br>MANUF'S DRG<br>MANUF'S SPEC./ BHFL SPEC.           | -DO-<br>-DO-<br>-DO-<br>-DO-     | 3<br>3<br>3<br>3 | -<br>-<br>-<br>- | 2<br><br><br>2 |                    |   |
| 1.12                                                                                | OIL SEALS & GASKETS                | 4.HV/IR<br><br>1.MATERIAL OF GASKET<br>2.SURFACE COND.<br>3.DIMENSIONS                | MA<br><br>MA<br>MA<br>MA | -DO-<br>VISUAL<br>VISUAL<br>MEASUREMENT       | 100%<br>100%<br>100%<br>SAMPLE | -DO-<br>MANUF'S DRG/SPECS<br>-<br>MANUF'S DRG               | -DO-<br>MANUF'S DRG./ SPECS.<br>FREE FROM VISUAL DEFECTS<br>MANUF'S DRG                | -DO-<br>-DO-<br>-DO-<br>-DO-     | 3<br>3<br>3<br>3 | -<br>-<br>-<br>- | 2<br><br><br>- |                    |   |
| BHEL                                                                                |                                    | PARTICULARS                                                                           |                          | BIDDER/VENDOR                                 |                                |                                                             |                                                                                        |                                  |                  |                  |                |                    |   |
|                                                                                     |                                    | NAME                                                                                  |                          |                                               |                                |                                                             |                                                                                        |                                  |                  |                  |                |                    |   |
|                                                                                     |                                    | SIGNATURE                                                                             |                          |                                               |                                |                                                             |                                                                                        |                                  |                  |                  |                |                    |   |
|                                                                                     |                                    | DATE                                                                                  |                          |                                               |                                |                                                             |                                                                                        |                                  |                  |                  |                |                    |   |
| BIDDER'S/VENDORS COMPANY SEAL                                                       |                                    |                                                                                       |                          |                                               |                                |                                                             |                                                                                        |                                  |                  |                  |                |                    |   |

|  |                                                     | QUALITY PLAN                                  |      | CUSTOMER :                |                 | PROJECT                                 |                           | SPECIFICATION :  |                    |
|-------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------|------|---------------------------|-----------------|-----------------------------------------|---------------------------|------------------|--------------------|
|                                                                                     |                                                     |                                               |      | BIDDER/ VENDOR            |                 | TITLE                                   |                           | NUMBER :         |                    |
|                                                                                     |                                                     |                                               |      | SYSTEM                    |                 | QUALITY PLAN                            |                           | SPECIFICATION :  |                    |
|                                                                                     |                                                     | SHEET 5 OF 9                                  |      |                           |                 | NUMBER PED-506-00-Q-007, REV-03         |                           | TITLE            |                    |
| SL. NO.                                                                             | COMPONENT/OPERATION                                 | CHARACTERISTIC CHECK                          | CAT. | TYPE/METHOD OF CHECK      | EXTENT OF CHECK | REFERENCE DOCUMENT                      | ACCEPTANCE NORM           | FORMAT OF RECORD | VOLUME III REMARKS |
| 1                                                                                   | 2                                                   | 3                                             | 4    | 5                         | 6               | 7                                       | 8                         | 9                | 10                 |
| 2.0                                                                                 | IN PROCESS                                          |                                               |      |                           |                 |                                         |                           |                  | 11                 |
| 2.1                                                                                 | STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR) | 1.WORKMANSHIP & CLEANNES                      | MA   | VISUAL                    | 100%            | -DO-                                    | GOOD FINISH               | LOG BOOK         | 3/2 -              |
|                                                                                     |                                                     | 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-            | RELEVANT SPEC./ASTM-E165                | MANUF'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 -                |
| BHEL                                                                                |                                                     | PARTICULARS                                   |      | BIDDER/VENDOR             |                 |                                         |                           |                  |                    |
|                                                                                     |                                                     | NAME                                          |      |                           |                 |                                         |                           |                  |                    |
|                                                                                     |                                                     | SIGNATURE                                     |      |                           |                 |                                         |                           |                  |                    |
|                                                                                     |                                                     | DATE                                          |      |                           |                 |                                         |                           |                  |                    |
|                                                                                     |                                                     |                                               |      |                           |                 | BIDDER'S/VENDORS COMPANY SEAL           |                           |                  |                    |

| <div></div> |                     | CUSTOMER :                             |    | PROJECT               |             | SPECIFICATION :            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
|------------------------------------------------------------------------------------------------|---------------------|----------------------------------------|----|-----------------------|-------------|----------------------------|----------------------------|--------------------|----|-----------------|---|---------------------------------------------------------|--|----------------|--|--------------------|--|
| QUALITY PLAN                                                                                   |                     | BIDDER/ VENDOR :                       |    | TITLE                 |             | NUMBER :                   |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
|                                                                                                |                     | SYSTEM                                 |    | QUALITY PLAN          |             | TITLE                      |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
| SHEET 6 OF 9                                                                                   |                     | CAT.                                   |    | TYPE/ METHOD OF CHECK |             | EXTENT OF CHECK            |                            | REFERENCE DOCUMENT |    | ACCEPTANCE NORM |   | FORMAT OF RECORD                                        |  | SECTION AGENCY |  | VOLUME III REMARKS |  |
| SL. NO.                                                                                        | COMPONENT/OPERATION | CHARACTERISTIC CHECK                   |    |                       |             |                            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
| 1                                                                                              | 2                   | 3                                      | 4  | 5                     | 6           | 7                          | 8                          | 9                  | 10 |                 |   | 11                                                      |  |                |  |                    |  |
| 2.4                                                                                            | SHEET STACKING      | 1.COMPLETENESS                         | MA | MEASUREMENT           | SAMPLE      | MANUF'R'S SPEC.            | MANUF'R'S SPEC.            | Log Book           | 2  | -               | - | (FOR MOTORS OF 2MW AND ABOVE)<br>* ON 10% RANDOM SAMPLE |  |                |  |                    |  |
|                                                                                                |                     | 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 |                                                         |  |                |  |                    |  |
|                                                                                                |                     | 1.COMPLETENESS                         | CR | VISUAL                | 100%        | MANUF'R'S SPEC./BHEL SPEC. | MANUF'R'S SPEC./BHEL SPEC. | Log Book           | 2  | -               | - |                                                         |  |                |  |                    |  |
| 2.5                                                                                            | WINDING             | 2.CLEANLINESS                          | CR | -DO-                  | -DO-        | -DO-                       | -DO-                       | Log Book           | 2  | -               | - | FOR MV MOTOR                                            |  |                |  |                    |  |
|                                                                                                |                     | 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  | -               | - |                                                         |  |                |  |                    |  |
| 2.6                                                                                            | IMPREGNATION        | 6.SURGE WITH STAND AND TAN. DELTA TEST | CR | -DO-                  | -DO-        | -DO-                       | -DO-                       | Log Book           | 2  | -               | 1 | THREE DIPS TO BE GIVEN                                  |  |                |  |                    |  |
|                                                                                                |                     | 1.VISCOSITY                            | MA | PHY. TEST             | AT STARTING | -DO-                       | -DO-                       | Log Book           | 2  | -               | - |                                                         |  |                |  |                    |  |
|                                                                                                |                     | 2.TEMP. PRESSURE VACCUIM               | MA | PROCESS CHECK         | CONTINUOUS  | -DO-                       | -DO-                       | Log Book           | 2  | -               | - |                                                         |  |                |  |                    |  |
|                                                                                                |                     | 3.NO. OF DIPS                          | MA | -DO-                  | -DO-        | -DO-                       | -DO-                       | Log Book           | 2  | -               | 1 |                                                         |  |                |  |                    |  |
| BHEL                                                                                           |                     | PARTICULARS                            |    | BIDDER/VENDOR         |             |                            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
|                                                                                                |                     | NAME                                   |    |                       |             |                            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
|                                                                                                |                     | SIGNATURE                              |    |                       |             |                            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
|                                                                                                |                     | DATE                                   |    |                       |             |                            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |
|                                                                                                |                     | BIDDER'S/VENDORS COMPANY SEAL          |    |                       |             |                            |                            |                    |    |                 |   |                                                         |  |                |  |                    |  |

| <div></div> |                           | QUALITY PLAN                                                    |             | CUSTOMER :            |                 | PROJECT                        |                       | SPECIFICATION :  |         |         |                                |                               |   |
|------------------------------------------------------------------------------------------------|---------------------------|-----------------------------------------------------------------|-------------|-----------------------|-----------------|--------------------------------|-----------------------|------------------|---------|---------|--------------------------------|-------------------------------|---|
|                                                                                                |                           |                                                                 |             | BIDDER/ VENDOR        |                 | TITLE                          |                       | NUMBER :         |         | TITLE   |                                |                               |   |
|                                                                                                |                           |                                                                 |             |                       |                 |                                |                       |                  |         |         |                                |                               |   |
| SHEET 7 OF 9                                                                                   |                           | SYSTEM                                                          |             | QUALITY PLAN          |                 | NUMBER PED-506-00-Q-007_REV-03 |                       | VOLUME III       |         | REMARKS |                                |                               |   |
| SL. NO.                                                                                        | COMPONENT/OPERATION       | CHARACTERISTIC CHECK                                            | CAT.        | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT             | ACCEPTANCE NORM       | FORMAT OF RECORD | SECTION | AGENCY  | P                              | W                             | V |
| 1                                                                                              | 2                         | 3                                                               | 4           | 5                     | 6               | 7                              | 8                     | 9                | 10      |         | 11                             |                               |   |
| 2.7                                                                                            | COMPLETE STATOR ASSEMBLY  | 4.DURATION                                                      | MA          | -DO-                  | -DO-            | -DO-                           | -DO-                  | Log Book         | 2       | -       | 1                              |                               |   |
|                                                                                                |                           | 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       |                                |                               |   |
| 2.9                                                                                            | COMPLETE ROTOR ASSEMBLY   | 3.HV                                                            | MA          | ELECT. TEST           | -DO-            | -DO-                           | -DO-                  | Log Book         | 2       | 1       |                                |                               |   |
|                                                                                                |                           | 1.RESIDUAL UNBALANCE                                            | CR          | DYN. BALANCE          | -DO-            | MFG SPEC./ ISO 1940            | MFG. DWG.             | Log Book         | 2       | 1       | VERIFICATION FOR MV MOTOR ONLY |                               |   |
| 2.10                                                                                           | ASSEMBLY                  | 2.SOUNDNESS OF DIE CASTING                                      | CR          | ELECT. (GROWLER TEST) | -DO-            | MFG. SPEC.                     | MFG. SPEC.            | Log Book         | 2       | 1       |                                |                               |   |
|                                                                                                |                           | 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       | -       | -                              |                               |   |
| BHEL                                                                                           |                           | 6. RTD, BTD & SPACE HEATER MOUNTING.                            | MA          | VISUAL                | 100%            | MFG SPEC. RELEVANT IS          | MFG SPEC. RELEVANT IS | Log Book         | 2       | 1       |                                |                               |   |
|                                                                                                |                           |                                                                 | PARTICULARS |                       | BIDDER/VENDOR   |                                |                       |                  |         |         |                                |                               |   |
|                                                                                                |                           |                                                                 | NAME        |                       |                 |                                |                       |                  |         |         |                                |                               |   |
|                                                                                                |                           |                                                                 | SIGNATURE   |                       |                 |                                |                       |                  |         |         |                                |                               |   |
|                                                                                                |                           | DATE                                                            |             |                       |                 |                                |                       |                  |         |         |                                | BIDDER'S/VENDORS COMPANY SEAL |   |

|  |                     | QUALITY PLAN                                                                                                                                                                                                                                                                                                                                                                                                                           |      | CUSTOMER :                                                                                                                                                                                                  |                                                                                                                       | PROJECT TITLE                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                      | SPECIFICATION : NUMBER :                                                                                                            |                                                                                                                 |
|-------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| SHEET 8 OF 9                                                                        |                     | BIDDER/ VENDOR :                                                                                                                                                                                                                                                                                                                                                                                                                       |      | QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03                                                                                                                                                                |                                                                                                                       | SPECIFICATION : TITLE                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                      | SECTION                                                                                                                             |                                                                                                                 |
| SL. NO.                                                                             | COMPONENT/OPERATION | CHARACTERISTIC CHECK                                                                                                                                                                                                                                                                                                                                                                                                                   | CAT. | TYPE/ METHOD OF CHECK                                                                                                                                                                                       | EXTENT OF CHECK                                                                                                       | REFERENCE DOCUMENT                                                                                                                                                                                                                                                        | ACCEPTANCE NORM                                                                                                                                                                                                                                                      | FORMAT OF RECORD                                                                                                                    | VOLUME III REMARKS                                                                                              |
|                                                                                     |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |                                                                                                                                                                                                             |                                                                                                                       |                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                      |                                                                                                                                     |                                                                                                                 |
| 1                                                                                   | 2                   | 3                                                                                                                                                                                                                                                                                                                                                                                                                                      | 4    | 5                                                                                                                                                                                                           | 6                                                                                                                     | 7                                                                                                                                                                                                                                                                         | 8                                                                                                                                                                                                                                                                    | 9                                                                                                                                   | 10                                                                                                              |
| 3.0                                                                                 | TESTS               | 1. TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.<br>2. ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.<br>3. VIBRATION & NOISE LEVEL<br>4. OVERALL DIMENSIONS AND ORIENTATION<br>5. DEGREE OF PROTECTION<br>6. MEASUREMENT OF RESISTANCE OF RTD & BTD<br>7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER<br>8. NAMEPLATE DETAILS<br>9. EXPLOSION FLAME PROOF NESS (IF SPECIFIED)<br>10. PAINT SHADE, THICKNESS & FINISH | MA   | ELECT. TEST<br><br>-DO-<br><br>-DO-<br><br>MEASUREMENT & VISUAL<br><br>ELECT. & MECH. TEST<br><br>-DO-<br><br>-DO-<br><br>VISUAL<br><br>EXPLOSION FLAME PROOF TEST<br><br>VISUAL & MEASUREMENT BY ELKOMETER | 1/TYPE/SIZE<br><br>100%<br><br>100%<br><br>100%<br><br>1/TYPE/ SIZE<br><br>100%<br><br>100%<br><br>100%<br><br>1/TYPE | IS-325/ BHEL SPEC./ DATA SHEET<br><br>-DO-<br><br>IS-12075 & IS-12065<br><br>APPROVED DRG/DATA SHEET<br><br>RELEVANT IS<br><br>BHEL SPEC. AND DATA SHEET<br><br>-DO-<br><br>-DO-<br><br>IS-325 & DATA SHEET<br><br>IS-3682 IS-8239 IS-8240<br><br>BHEL SPEC. & DATA SHEET | IS-325/ BHEL SPEC./ DATA SHEET<br><br>-DO-<br><br>IS-12075 & IS-12065<br><br>APPROVED DRG/DATA SHEET & RELEVANT IS<br><br>BHEL SPEC. AND DATA SHEET<br><br>-DO-<br><br>-DO-<br><br>IS-325 & DATA SHEET<br><br>IS-3682 IS-8239 IS-8240<br><br>BHEL SPEC. & DATA SHEET | TEST REPORT<br><br>-DO-<br><br>-DO-<br><br>INSPC. REPORT<br><br>TC<br><br>-DO-<br><br>-DO-<br><br>INSPC. REPORT<br><br>TC<br><br>TC | 2 1* 1<br><br>2 1\$ 1<br><br>2 1\$ 1<br><br>2 1\$ 1<br><br>2 1\$ 1<br><br>2 1\$ 1<br><br>2 1\$ 1<br><br>2 1\$ 1 |
| BHEL                                                                                |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |                                                                                                                                                                                                             |                                                                                                                       |                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                      |                                                                                                                                     |                                                                                                                 |
| BIDDER/VENDORS COMPANY SEAL                                                         |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |                                                                                                                                                                                                             |                                                                                                                       |                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                      |                                                                                                                                     |                                                                                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                             |  |                              |  |                        |  |                                                                                |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------|--|------------------------------|--|------------------------|--|--------------------------------------------------------------------------------|--|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  | <b>QUALITY PLAN</b>         |  | <b>CUSTOMER :</b>            |  | <b>PROJECT TITLE</b>   |  | <b>SPECIFICATION : NUMBER :</b>                                                |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                             |  | <b>BIDDER/ VENDOR :</b>      |  | <b>QUALITY PLAN</b>    |  | <b>SPECIFICATION :</b>                                                         |  |
| <b>SHEET 9 OF 9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | <b>SYSTEM CAT.</b>          |  | <b>TYPE/ METHOD OF CHECK</b> |  | <b>EXTENT OF CHECK</b> |  | <b>ITEM: AC ELECT. MOTORS 55 KW &amp; ABOVE (LV &amp; MV) FORMAT OF RECORD</b> |  |
| <b>COMPONENT/OPERATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  | <b>CHARACTERISTIC CHECK</b> |  | <b>3</b>                     |  | <b>4</b>               |  | <b>5</b>                                                                       |  |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | <b>3</b>                    |  | <b>6</b>                     |  | <b>7</b>               |  | <b>8</b>                                                                       |  |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | <b>9</b>                    |  | <b>10</b>                    |  | <b>11</b>              |  | <b>12</b>                                                                      |  |
| <b>NOTES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |                             |  |                              |  |                        |  |                                                                                |  |
| 1. DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.<br>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.<br>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.<br>4. WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. |  |                             |  |                              |  |                        |  |                                                                                |  |
| <u>Legends for Inspection agency</u><br>1. BHEL/CUSTOMER<br>2. VENDOR (MOTOR MANUFACTURER)<br>3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)<br>P. PERFORM<br>W. WITNESS<br>V. VERIFY                                                                                                                                                                                                                                                                                                                                                       |  |                             |  |                              |  |                        |  |                                                                                |  |
| <b>BHEL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  | <b>PARTICULARS</b>          |  | <b>BIDDER/VENDOR</b>         |  |                        |  |                                                                                |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | <b>NAME</b>                 |  |                              |  |                        |  |                                                                                |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | <b>SIGNATURE</b>            |  |                              |  |                        |  |                                                                                |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | <b>DATE</b>                 |  |                              |  |                        |  |                                                                                |  |
| <b>BIDDER'S/VENDORS COMPANY SEAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                             |  |                              |  |                        |  |                                                                                |  |

| <div>  </div> |  | CUSTOMER :                                                   |  | PROJECT                         |  | SPECIFICATION :                |  |                          |  |
|--------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------|--|---------------------------------|--|--------------------------------|--|--------------------------|--|
|                                                                                                  |  | BIDDER/ VENDOR                                               |  | TITLE                           |  | NUMBER :                       |  |                          |  |
|                                                                                                  |  | SYSTEM                                                       |  | QUALITY PLAN                    |  | SPECIFICATION                  |  |                          |  |
| SHEET 1 OF 2                                                                                     |  | QUALITY PLAN                                                 |  | NUMBER PED-506-00-Q-006, REV-01 |  | TITLE                          |  |                          |  |
| COMPONENT/OPERATION                                                                              |  | CHARACTERISTICS CHECK                                        |  | EXTENT OF CHECK                 |  | REFERENCE DOCUMENT             |  | ACCEPTANCE NORM          |  |
| SL. NO.                                                                                          |  | CAT.                                                         |  | TYPE/METHOD OF CHECK            |  | FORMAT OF RECORD               |  | AGENCY                   |  |
| 1                                                                                                |  | 2                                                            |  | 3                               |  | 4                              |  | 5                        |  |
| 1.0 ASSEMBLY                                                                                     |  | 1.WORKMANSHIP                                                |  | 100%                            |  | MANUF'S SPEC                   |  | MANUF'S SPEC             |  |
|                                                                                                  |  | 2.DIMENSIONS                                                 |  | -DO-                            |  | MFG. DRG./ MFG. SPEC.          |  | MFG. DRG./ MFG. SPEC.    |  |
|                                                                                                  |  | 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE |  | 100%                            |  | MFG.SPEC./ RELEVANT IS         |  | MFG.SPEC. RELEVANT IS    |  |
| 2.0 PAINTING                                                                                     |  | 1.SHADE                                                      |  | VISUAL                          |  | MANUF'S SPEC                   |  | BHEL SPEC. SAME AS COL.7 |  |
| 3.0 TESTS                                                                                        |  | 1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.      |  | 100%                            |  | IS-325/ BHEL SPEC./ DATA SHEET |  | TEST REPORT              |  |
|                                                                                                  |  | 2.OVERALL DIMENSIONS & ORIENTATION                           |  | 100%                            |  | APPROVED DRG/DATA SHEET        |  | INSPN. REPORT            |  |
| BHEL                                                                                             |  | PARTICULARS                                                  |  | BIDDER/VENDOR                   |  | NAME                           |  | SIGNATURE                |  |
|                                                                                                  |  |                                                              |  |                                 |  |                                |  |                          |  |
|                                                                                                  |  |                                                              |  |                                 |  |                                |  |                          |  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                       |                 |                      |                                       |                     |                          |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|-----------------|----------------------|---------------------------------------|---------------------|--------------------------|---------------|
|                                                                                                                                                                                                                                                                                                                                                        | QUALITY PLAN        |                       | CUSTOMER :      |                      | PROJECT TITLE                         |                     | SPECIFICATION : NUMBER : |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           | BIDDER/ :           |                       | BIDDER/ :       |                      | QUALITY PLAN                          |                     | SPECIFICATION : TITLE :  |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           | VENDOR              |                       | SYSTEM          |                      | NUMBER PED-506-00-Q-006, REV-01       |                     | SECTION                  |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           | SHEET 2 OF 2        |                       | CAT.            |                      | ITEM AC.ELECT. MOTORS BELOW 55KW (LV) |                     | VOLUME III               |               |
| SL. NO.                                                                                                                                                                                                                                                                                                                                                                                                                                   | COMPONENT/OPERATION | CHARACTERISTICS CHECK | EXTENT OF CHECK | TYPE/METHOD OF CHECK | REFERENCE DOCUMENT                    | ACCEPTANCE NORM     | FORMAT OF RECORD         | AGENCY        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                       |                 |                      |                                       |                     |                          | P W V         |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                         | 2                   | 3                     | 4               | 5                    | 6                                     | 7                   | 8                        | 9             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     | 3.NAMEPLATE DETAILS   | MA              | VISUAL               | 100%                                  | IS-325 & DATA SHEET | IS-325 & DATA SHEET      | INSPN. REPORT |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                       |                 |                      |                                       |                     |                          | 2 1 -         |
| <p>NOTES:</p> <p>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</p> <p>2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.</p> <p>3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW . ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.</p> |                     |                       |                 |                      |                                       |                     |                          |               |
| <p><u>Legends for Inspection agency</u></p> <p>1. BHEL/CUSTOMER</p> <p>2. VENDOR (MOTOR MANUFACTURER)</p> <p>3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)</p> <p>P. PERFORM</p> <p>W. WITNESS</p> <p>V. VERIFY</p>                                                                                                                                                                                                                    |                     |                       |                 |                      |                                       |                     |                          |               |
| BHEL                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |                       | PARTICULARS     |                      | BIDDER/VENDOR                         |                     |                          |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                       | NAME            |                      |                                       |                     |                          |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                       | SIGNATURE       |                      |                                       |                     |                          |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |                       | DATE            |                      |                                       |                     |                          |               |
| BIDDER'S/VENDORS COMPANY SEAL                                                                                                                                                                                                                                                                                                                                                                                                             |                     |                       |                 |                      |                                       |                     |                          |               |

**SUB-VENDOR LIST FOR ELECTRICAL ITEMS**

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

### ANNEXURE III

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

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V  
 (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

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



## SECTION - 3.24: CABLES

### 1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cables.

### 2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) 19/33 kV grade XLPE insulated armoured FRLS power cables
- b) 11/11 kV grade XLPE insulated armoured FRLS power cables
- c) 6.6/6.6 kV grade XLPE insulated armoured FRLS cables
- d) 1.1 kV grade XLPE insulated armoured FRLS cables
- e) 1.1 kV grade XLPE insulated armoured FRLS control cables
- f) Trailing cables
- g) Shielded cables
- h) Telephone cables
- i) Fiber optic cables

### 3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and / or supplemented by this specification.

- |                     |                                                                  |
|---------------------|------------------------------------------------------------------|
| a) IS: 3975         | Mild steel wires formed wires and tapes for armouring of cables. |
| b) IS: 4905         | Methods for random sampling.                                     |
| c) IS: 5831         | PVC insulation and sheath of electric cables.                    |
| d) IS: 7098 Part-I  | Cross-linked polyethylene insulated PVC sheathed cables (LV)     |
| e) IS: 7098 Part-II | Cross-linked polyethylene insulated PVC sheathed cables (HV)     |
| f) IS: 8130         | Conductors for insulated electric cables and flexible cords.     |
| g) IS: 10418        | Drums for electric cables.                                       |
| h) IS: 10810        | Methods of tests for cables.                                     |
| i) IS: 3961         | Recommended current ratings for cables                           |

### 4.0.0 TECHNICAL REQUIREMENTS

#### 4.1.0 Power cables shall be provided for the following systems:

- 33 kV earthed system having phase fault current and earth fault current of 25 kA.
- 11 kV unearthed system having phase fault current of 50 kA and earth fault current of 300 A.
- 6.6 kV unearthed system having phase fault current of 31.5 kA and earth fault current of 300 A.
- 415 V earthed system having phase fault current and earth fault current of 65/50 kA.
- 220 V DC unearthed system having fault current of not less than 25 kA.

#### 4.2.0 Power cables shall be sized to withstand the system fault current for the fault clearing time indicated below:

- Breaker operated Motor feeders and transformer feeders: 0.16 second.
- Breaker operated outgoing feeders: 0.5 second.
- Tie between two switchgear: 0.5 second.
- Incomers: 1 second.



- 4.3.0 Power cables shall be sized to satisfy the following Criteria:
- To withstand specified system short circuit current for the specified fault clearing time.
  - To carry full load current under applicable installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
  - To limit the voltage drop under steady state/transient state conditions to permissible values.
- 4.4.0 Cables shall be armoured type only.
- 4.5.0 Power cables shall be XLPE insulated. Control cables shall be PVC / XLPE insulated.
- 4.6.0 PVC insulation shall be suitable for continuous conductor temperature of 70°C and short circuit conductor temperature of 160°C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.
- 4.7.0 Cables for 33 kV system shall be rated for 19/33 kV earthed grade, cables for 11 kV system shall be rated for 11/11 kV unearthed grade and Cables for 6.6 kV system shall be rated for 6.6/6.6 kV unearthed grade. Cables for 415/230 V AC and 220 V DC shall be rated for 1.1 kV grade.
- 4.8.0 To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have non-propagating, and self-extinguishing flame retardant, low smoke (FRLS) characteristics. Outer sheath shall be of PVC black in colour. These cables shall meet the following test requirements.
- Oxygen index of minimum 29 when tested as per IS 10810 Part-58
  - Temperature index of minimum 250°C when tested as per IS 10810 Part-64
  - Acid gas emission of maximum 20% when tested as per IS 10810 Part-59 Average light transmission of 40% minimum when tested as per IS 10810 Part-63 (average smoke density is maximum 60%)
  - Flame test requirements as per IS 10810 Parts-53 and 62
  - Flame retardant test requirements as per IS 10810 Part-61
- 4.9.0 For power cables, copper conductor shall be used for current rating of up to 10 A. For higher current rating, conductor can be aluminium/copper. Minimum size of copper conductor shall be 2.5 sq.mm and aluminium conductor shall be 6 sq.mm.
- 4.10.0 Conductor of control cables shall have plain annealed copper. The minimum size of control cable shall be of 1.5 sq.mm. For CT circuit minimum size shall be 2.5 sq.mm copper. Control cables shall have 20% spare cores.
- 4.11.0 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and knee point voltage. Minimum 2.5 sq.mm copper cables shall be used for connection of CT to load. In case 2.5 sq.mm size impose unacceptably high burden on CTs, 4 sq.mm copper shall be used. Voltage transformer leads shall be checked for voltage drop which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 2.5 sq.mm copper conductor exceeds this value, higher conductor sizes shall be used.
- 4.12.0 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.
- 4.13.0 Design ambient air temperature and ground temperature shall be considered at 50°C and 40°C respectively for cable sizing.
- 4.14.0 For 11 kV & 6.6 kV cables, screen of each core shall be sized to withstand 300 A for 1 sec. For 33 kV cables, screen of each core shall be sized to withstand system earth fault current for 0.16 sec.



- 4.15.0 For HT motors the voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 2.5% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 5% of rated voltage
- 4.16.0 For LT motors the voltage drop in the cable, during motor starting condition, shall be limited to 15% and during full load running condition, shall be limited to 3% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 6% of rated voltage.
- 4.17.0 Cables for the following systems shall be fire survival type.
- DC emergency lube oil pumps
  - DC seal oil pump
  - DC emergency lighting cables for main building.
  - Batteries to chargers and DC distribution boards
  - Turbine lub oil pumps
  - Jacking oil pumps
  - Emergency turbine trip by push button in control room
  - Inter trip cables between Boiler master fuel trip and turbine trip relays
  - Inter trip cables between Generator trip relays and turbine trip relays/400 kV circuit breaker/generator field breaker/UT breakers
- 4.18.0 Method of curing for HT XLPE insulation shall be **gas/steam curing**.
- 4.19.0 Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.
- 4.20.0 For armoured cables, armouring shall be of aluminium for single core cables. For multicore armoured cables, armouring shall be of galvanised steel.
- 4.21.0 All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.
- 4.22.0 Multi-core cable color coding shall be as follows:
- Red, yellow, blue, black and gray for five core cables
  - Outer sheath shall be of black in colour.
  - For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
- 4.23.0 Three core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:
- Circular stranded and compacted aluminium conductor
  - Extruded semi conducting compound as conductor screen
  - Extruded XLPE insulation
  - Extruded semi conducting compound as insulation screen
  - Copper tape as metallic screen for each core
  - Extruded PVC inner sheath
  - Galvanised steel formed wire/strip
  - Extruded FRLS PVC outer sheath
- 4.24.0 Single core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:
- Circular stranded and compacted aluminium conductor
  - Extruded Semi conducting compound as conductor screen
  - Extruded XLPE insulation
  - Extruded Semi conducting compound as insulation screen
  - Copper tape as metallic screen
  - Hard drawn aluminium wire armour
  - Extruded FRLS PVC outer sheath



4.25.0 Multicore 1.1 kV earthed grade cables shall constitute the following:

- Circular / shaped, stranded aluminium conductor (compacted for >10 sq.mm)
- Extruded XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.26.0 Single core 1.1 kV earthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded XLPE insulation
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

4.27.0 **Trailing power and control cables for mobile equipment shall constitute the following:**

Unearthed grade HT power cables, earthed grade LV power cables and control cables shall be flexible trailing with annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed. For HT cables, insulation screen shall be provided. Cables shall conform to applicable IS/IEC standard requirements.

4.28.0 **Fire survival cables**

Fire survival cable shall be of copper conductor and comply with IEC-60331 (withstanding 750 degree C temperature for 3 hours). Also the halogen acid contents in outer sheath shall not be more than 2% when tested as per IEC-60754 and the smoke density in percent light absorption shall not exceed 20% when tested as per ASTM-D-2843. 1.1 kV earthed grade fire survival cables shall constitute the following:

- Circular/shaped stranded and compacted annealed copper conductor
- Elastomeric materials (XLPE, EPR, SR, or LSOH) insulated
- Glass mica taped
- Extruded FRLS compound or LSOH material as inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS compound or LSOH material as inner sheath

4.29.0 Multicore 1.1 kV earthed grade control cables shall constitute the following as per IS:1554-1 / 7098-1:

- Multi stranded annealed copper conductor
- Extruded PVC / XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.30.0 Multi pair 1.1 kV earthed grade, overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.31.0 Multi pair 1.1 kV earthed grade, individual and overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair



- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

#### 4.32.0 Cable drums

Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. All wooden parts shall be manufactured from durable quality wood duly seasoned and treated with copper nepthenates or zinc nepthenates for preserving the wood. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

#### 4.33.0 Cable identification system

- In addition to manufacturer's identification on cables as per IS, following marking shall also be embossed/printed on the outer sheath at an interval of one metre throughout the length of cables.
  - BIS mark
  - Manufacturer's name and or trade mark.
  - Year of manufacture
  - Cable code
  - Type of cable and voltage class.
  - Nominal cross section area of conductor and no.of cores.
  - Progressive sequential length making.
- Cables shall be marked as having FRLS outer sheath at every 5 meters.
- The embossing/printing shall be progressive, automatic, in line and marking shall be legible and indelible.
- Multi-core cable color coding shall be as follows:
  - Red, yellow and blue for three core cables
  - Outer sheath shall be of black in colour.
  - For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
  - For multi pair cables, each pair shall be coloured and numbered.

#### 5.0.0 TESTS

Cables offered shall be type tested and proven type. Routine tests shall be carried out on 100% drums. Type tests, special tests and acceptance tests shall be carried out on 1 drum selected on random basis, out of every 10 or less number of drums of each type and size of cable of each lot. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc.

#### 5.1.0 Type Test

- Tests on conductor



- i) Annealing Test (for copper)
- ii) Tensile test (for aluminium)
- iii) Wrapping test (for aluminium)
- iv) Resistance test
  
- b) Tests for armour wires/strips
- c) Tests for thickness of insulation and sheath
- d) Physical tests for insulation
  - i) Tensile strength and elongation at break
  - ii) Ageing in air oven
  - iii) Shrinkage test
  - iv) Hot test
  - v) Water absorption (gravimetric)
- e) Physical test for outer sheath
  - i) Tensile strength and elongation at break
  - ii) Ageing in air oven
  - iii) Shrinkage test
  - iv) Hot deformation
  - v) Heat shock test
  - vi) Loss of mass test in air oven
  - vii) Thermal heat stability test (as per IS : 5831)
  - viii) Bleeding and blooming test
- f) Anti-termite and anti-rodent test (on outer sheath).
- g) Partial discharge test
- h) Bending test
- i) Dielectric power factor test
  - i) As a function of voltage
  - ii) As a function of temperature
- j) Insulation resistance (volume resistivity) test
- k) Heating cycle test
- l) Impulse withstand test
- m) High voltage test
- n) Flammability test
- o) Cold impact test

#### 5.2.0 Acceptance Test

- a) Annealing test (for copper)
- b) Tensile test (for aluminium)
- c) Wrapping test (for aluminium)
- d) Conductor resistance test
- e) Test for thickness of insulation and sheath
- f) Hot set test for insulation
- g) Tensile strength and elongation at break test for insulation and outer sheath
- h) Partial discharge test (for screened cables)
- i) High voltage test
- j) Insulation resistance (volume resistivity) test

#### 5.3.0 Routine Test

- a) Conductor resistance test
- b) Partial discharge test



- c) High voltage test

#### 5.4.0 Special Test

- a) Oxygen index test as per IS 10810 Part-58
- b) Temperature index test as per IS 10810 Part-64
- c) Acid gas generation test as per IS 10810 Part-59
- d) Smoke generation test as per IS 10810 Part-63
- e) Flammability tests as per IS 10810 Parts-53 and 62
- f) Flame retardant test as per IS 10810 Part-61

#### 5.5.0 Site Test

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- a) Insulation resistance test
- b) High voltage test

#### 6.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted 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



#### **4.0.0 TECHNICAL REQUIREMENTS OF LOW VOLTAGE VFDS**

- 4.1.0 VFDS shall be rated for 415 V supply voltage. If isolation transformer is required at input, the same shall be provided.
- 4.2.0 VFDS shall be sized for the specific application with a design margin of atleast 10% over the motor rating. The drive shall be rated to operate at a design ambient of 50°C. It shall be ensured that harmonics are filtered and not reflected at source.
- 4.3.0 Variable speed drives shall be provided for better speed response, range ability, control stability and for ease of control, and smooth, efficient and optimum speed operation of the machine drives.
- 4.4.0 The drive shall be housed in sheet steel enclosure of IP-42 degree of protection. The unit shall be complete with ACB/MCCB at incomer, contactor, semiconductor fuses, meters, indication lamps, annunciations, protections, redundant cooling fans etc.
- 4.5.0 VFDS shall be at-least 12 Pulse type with active front end rectifiers with total harmonic current distortion limited to less than 4%.
- 4.6.0 For VFDs controlled LT motors, it shall be IE2 class as per IS 12615.
- 4.7.0 VFDS system shall have the following features:-
  - High input line-side power factor throughout the speed range.



- Low harmonics on the input line-side, with the total and individual harmonic contents not exceeding the limits established in IEEE-519.
- Low load side harmonics with near sinusoidal current in the drive circuit.
- Suitable for regenerative operation as may be required for the drive application.
- Input and output side choke
- Soft start and soft stop, with capability for bi-directional operation of the drive as may be required.
- Reduced shoot through faults.
- High starting torque as may be required for the drive application.
- Suitable for various drives operating with driven equipment having constant torque, constant power, or load torque varying with square or cube of speed.
- Faster response and have a wide speed range.
- Greater tolerance to load side drive machine parameter variations.
- Wide range of low frequency and super synchronous speed frequency range of operation as may be required.
- Low torque pulsations throughout the lowest & highest frequency range.
- Stability throughout the lowest and highest load range.
- Reduced voltage spikes inflicted on the motor / VFDS equipment that can occur during commutation.
- VFDS shall be capable of flying restart.
- VFDS shall have dynamic braking unit and resistor feature.
- By pass arrangement.

4.8.0 VFDS will comprise frequency converter having following features:

- Voltage or Current Source DC link Pulse Width Modulated (PWM) Converter configuration suitable for operation at automatically produced fixed ratio of Voltage / Frequency (V / F) throughout the complete speed range of the motor; and for operation in constant torque and constant power mode as appropriate. The converter will comprise line commutated power converter connected to AC mains either directly or by a suitably rated converter transformer.
- For the Voltage Source Inverter Configuration, the DC link voltage output by the power supply converter will be smoothened by an L-C circuit and the constant voltage output that will be fed to a forced commutated three phase inverter output system. The system will be complete with shunt capacitors selected to cater to the reactive power requirements of the motor.
- For the Current Source Inverter Configuration, the DC link voltage output by the power supply converter will be by a smoothing choke in series with the converter and the constant current output of the choke will be fed to a suitably commutated three phase inverter output system. The smoothing reactor will be sized to avoid conditions of discontinuous current operation of the converter at its lowest frequency of operation and will be uniformly insulated and protected against voltage surges that could occur during load throw-off.
- Provided with suitable input transformer if required to transform the input system network voltage to the optimal voltage of the converter and to reduce the short circuit capacity and to reduce 'line notching' that can occur during commutation. The Input transformer will have appropriate phase shifting multiple windings to eliminate the 5th & 7th harmonics and their multiples.
- Suitable regulating equipment that will be so designed as to enable the drive motor system to respond to load change with good dynamic accuracy, excellent speed holding accuracy and fine speed setting resolution. From the instrumentation control system, isolated 4-20 mA dc controller output signal will be made available as a set point for the speed controller in the regulation system. The system will include as part of the speed controller any transducer/ converter that may be required to interface with the above signal. Facility for signal measurement at important points in the regulating system will also be provided.



- Independently adjustable voltage boost for VFDS start up and operation at the lower end of the frequency.
  - Separately adjustable ramp up and ramp down time facilities.
  - Complete features for drive soft start and soft or extended stop as required with features required for bi-directional operation of the drive as may be required for the particular application.
  - Close loop control to keep output voltage unaffected by system voltage and load changes. Regulation of output voltage will not be more than plus 2% to minus 2% under steady state (zero to full load) and 8% under transient conditions.
  - Maximum drift in set frequency will be plus 1% to minus 1%.
  - All facilities as required for onsite adjustments of current limits, trip time, maximum frequency, minimum frequency, start compensation, voltage boost, slip compensation, accuracy rate, deceleration rate and others as required.
  - Comprehensive protection and fault display circuit including under / voltage (supply, over current, short circuit / earth fault due to inverter and / or motor fault , internal / external fault provisions for tripping unit. covering as a minimum Over current protection, fast acting short circuit & transient suppression circuits, Overload protection, Phase sequence monitoring and protection, Single phase protection, Mains & Internally generated Transient Over Voltage Protection, Under Voltage and mains supply failure protection, Control supply failure, IGBT fuse failure, Gate suppression for output circuit faults, Thermistor protection relay for protection of windings of motors greater than or equal to 75 kW, necessary di/dt & dv/dt protection, Device / Cubicle overheating protection, Ventilation failure, and any other protection as required for the type of scheme provided.
  - Where closed loop dynamic and fast speed response is required for drives, necessary multi loop control system will be provided complete with tachometers provided in the drive shaft.
- 4.9.0 The control system will consist of a multi loop system having two internal loops. One loop is for speed control and the other is for the control of current. Each loop will have its own controller, along with an acceleration ramp function, which sets the desired value of the speed in accordance with a linear ramp function and thus prevents sudden variation in the controller input.
- 4.10.0 The primary controlled variable will be speed which will be measured by means of a tachometer, which will be provided on the drive shaft and compared with the reference speed input. The error in speed will actuate a speed controller to establish the reference current input. This reference value will be subtracted from the actual current value and the error signal actuates the current controller, the output of this should be connected to the gate control unit, which controls the firing of the IGBT.
- 4.11.0 The inner current loop is made more active than the speed control loop. The speed and current controllers will be capable of accepting the form and type of feedback signal provided by the error detector and must provide at its output a signal of the proper type to operate the IGBT.
- 4.12.0 All necessary indication and monitoring equipment that will as a minimum include speed indicator for motors with a provision for repeat indication signal for use with DCS instrumentation system, speed reference, speed feedback, current reference, current feedback, regulated power supply voltages; voltmeter, ammeter, frequency, power factor meter, kW meter at mains input supply side, pulse output meter; voltmeter, ammeter, frequency, kW meter torque meter kW meter and speed indicator on the load side.
- 4.13.0 Audio visual Alarm annunciation (with visual and audio alarm acknowledge facilities) as required that will as a minimum include drive in monitoring mode, drive in regenerating mode, control electronic power supply, over temperature, motor over current, rectifier over current, motor overload, any other motor / converter faults.



- 4.14.0 Necessary Input and output Filters will be provided at appropriate locations to suppress harmonics at the input and the output of the VFDS converter system and to improve the input power factor.
- 4.15.0 The VFDS panel will be located indoors inside electrical rooms. The VFDS panel will have self-ventilating & cooling fans fed with power drawn from within the VFDS panel complete with fan motor starters including switch & HRC fuses, contactors & overload relays as per details given for MCC in the previous sections of this report.
- 4.16.0 VFDS unit will be controlled from following 3 different locations
- VFDS panel
  - Local Operator Panel or Local Control Station
  - DCS
- 4.17.0 Following minimum control facilities will be provided on each of the VFDS Panel and the Local Operator Panel:-
- Incoming switch and HRC fuses.
  - Start / Stop PBs to switch ON / OFF of the drive.
  - All necessary contactors and switch with HRC fuses or current limiting circuit breakers for the drive control and protection along with overload protection.
  - Raise / Lower PBs for speed variation of the drive.
  - Auto / Manual Selector Switch for selection of the mode of operation.
- 4.18.0 In Auto mode, frequency will be controlled from the instrument control PLC / DCS system by a 4 to 20 mA signal. For ON / OFF control of the motor in the Auto mode, 4-20 mA interlock signal from instrumentation PLC system will be wired to the VFDS panel.
- 4.19.0 In the Manual mode, the Selector Switch will be provided to select the motor control either from VFDS Panel or from the field.
- Drive Ready Indication and
  - Speed Indicator
  - DCS interface covering :-
  - Wiring of 4-20 mA signal input from DCS/PLC for speed variation.
  - Wiring of DCS / OFF input signal / contact for motor Start / Stop.
  - Wiring of 4-20 mA signal output to DCS/PLC for speed indication.
  - Wiring of contacts to remote for Drive Ready Indication

## 5.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL-7035.

## 6.0.0 TESTS

All the equipment supplied shall be of type tested quality. Type test reports shall be submitted for each voltage class and current rating.



### 7.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Technical data sheet
- General arrangement and section drawing
- Single line diagram & Schematic wiring diagrams
- Metering and protection drawing
- Foundation Plan & loading details
- VFDS sizing calculation
- Test reports
- Manufacturing quality plan



**TECHNICAL SPECIFICATION  
FOR  
2x660 MW UDANGUDI TPP-STAGE I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
(UPTO 100T)**

**SECTION-I**

**SUB-SECTION-IC**

**REV. 00**

**DATE: MAR 2020**

## SUB SECTION-IC

### DATA SHEET-A

| TABLE -1 |                                    |                         |              |              |               |             |           |
|----------|------------------------------------|-------------------------|--------------|--------------|---------------|-------------|-----------|
| S.N.     | AREA /<br>EQUIPMENT<br>DESCRIPTION | Type                    | QTY<br>(nos) | CAPACITY (T) | LIFT (M)      | SPAN<br>(M) | TRAVEL(M) |
| 1        | CWPH                               | DOUBLE<br>GIRDER<br>EOT | 1            | 65/18T       | 17.5M/18<br>M | 12.7M       | 79.5M     |
| 2        | BC bay                             | DOUBLE<br>GIRDER<br>EOT | 2            | 35T          | 12.8M         | 10M         | 42.4M     |
| 3        | Heavy material<br>store            | DOUBLE<br>GIRDER<br>EOT | 1            | 15T          | 5.5M          | 17.82M      | 200M      |
| 4        | Sea water outfall<br>pump house    | DOUBLE<br>GIRDER<br>EOT | 1            | 15T          | 19.7M         | 7.2M        | 20M       |
| 5        | Sea water intake<br>pump house     | DOUBLE<br>GIRDER<br>EOT | 1            | 12.5T        | 21.7M         | 8.7M        | 35.7M     |
| 6        | Workshop                           | DOUBLE<br>GIRDER<br>EOT | 1            | 10T          | 5M            | 10.65M      | 42M       |



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\* Information's are to be furnished by bidder during detail engineering stage only.

| Sr. No.      |    | DESCRIPTION                                                                           | TECHNICAL PARTICULARS                                                                           |                          |
|--------------|----|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------|
| <b>1.0.0</b> |    | <b>General</b>                                                                        |                                                                                                 |                          |
| <b>1.1.0</b> |    | <b>Name of manufacturer</b>                                                           | *                                                                                               |                          |
|              | a. | EOT Crane                                                                             | *                                                                                               |                          |
|              | b. | Crane motors                                                                          | *                                                                                               |                          |
|              | c. | Runway conductors                                                                     | *                                                                                               |                          |
| <b>1.2.0</b> |    | <b>Weight of equipments</b>                                                           |                                                                                                 |                          |
|              | a. | Bridge assembly                                                                       | *                                                                                               |                          |
|              | b. | Trolley assembly                                                                      | *                                                                                               |                          |
|              | c. | Total crane weight                                                                    | *                                                                                               |                          |
|              | d. | Total weight of the gantry rail                                                       | *                                                                                               |                          |
|              | e. | Total weight of DSL                                                                   | *                                                                                               |                          |
|              | f. | Total weight of all the equipments under this specification                           | *                                                                                               |                          |
| <b>1.3.0</b> |    | <b>Design, fabrication and testing of the crane confirm to standard / code number</b> | Mechanical and Electrical as per IS: 3177-2006 & Structure design in accordance to IS 807:2006. |                          |
| <b>1.4.0</b> |    | <b>Number of crane</b>                                                                | Refer <b>Table -1</b> above                                                                     |                          |
| <b>1.5.0</b> |    | <b>Crane classification</b>                                                           | M5 Mechanical and M7 Electrical as per IS: 807-2006 and 13834 (part-5)-1993, IS 3177            |                          |
| <b>1.6.0</b> |    | <b>Suitable for outdoor or indoor duty</b>                                            | Indoor                                                                                          |                          |
| <b>1.7.0</b> |    | <b>Capacity</b>                                                                       |                                                                                                 |                          |
| <b>1.7.1</b> |    | <b>Main hoist</b>                                                                     |                                                                                                 |                          |
|              | a. | Rated SWC – tonnes                                                                    | Refer <b>Table -1</b> above                                                                     |                          |
|              | b. | Test load SWC – tonnes                                                                | Rated SWC and over load test : 125% of SWC                                                      |                          |
| <b>1.7.2</b> |    | <b>Aux. hoists</b>                                                                    |                                                                                                 |                          |
|              | a. | Rated SWC – tonnes                                                                    | Refer <b>Table -1</b> above                                                                     |                          |
|              | b. | Test load SWC – tonnes                                                                | Rated SWC and over load test : 125% of SWC                                                      |                          |
| <b>1.8.0</b> |    | <b>Span</b>                                                                           | Refer <b>Table -1</b> above                                                                     |                          |
| <b>1.9.0</b> |    | <b>Operation from</b>                                                                 | Pendent Push Button+ Radio remote control                                                       |                          |
| <b>2.00</b>  |    | <b>CRANE PERFORMANCE</b>                                                              |                                                                                                 |                          |
| <b>2.1.0</b> |    | Crane speed with full load                                                            | <b>Full speed M/Min</b>                                                                         | <b>Creep speed M/Min</b> |
|              | a. | Main hoist                                                                            | 2 MPM                                                                                           | 0.2                      |



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|              |    |                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |
|--------------|----|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
|              |    |                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                      | (10% of main speed thru' VVVF drives)        |
|              | b. | Aux. hoist                                               | 5 MPM                                                                                                                                                                                                                                                                                                                                                                                                                                | 0.5<br>(10% of main speed thru' VVVF drives) |
|              | c. | Trolley travel (CT)                                      | 10.0 MPM                                                                                                                                                                                                                                                                                                                                                                                                                             | 1.0<br>(10% of main speed thru' VVVF drives) |
|              | d. | Longitudinal bridge travel (LT)                          | 15.0 MPM                                                                                                                                                                                                                                                                                                                                                                                                                             | 1.5<br>(10% of main speed thru' VVVF drives) |
| <b>2.2.0</b> |    | Acceleration values                                      | LT motion (bridge travel)                                                                                                                                                                                                                                                                                                                                                                                                            | CT motion (trolley travel)                   |
|              |    |                                                          | As per IS: 3177                                                                                                                                                                                                                                                                                                                                                                                                                      | As per IS: 3177                              |
| <b>2.3.0</b> |    | <b>Lift in Metres</b>                                    | The lifting rope shall have 2 full turns in drums at the zero level.                                                                                                                                                                                                                                                                                                                                                                 |                                              |
|              | a. | Main Hoist                                               | Refer <b>Table -1</b> above                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |
|              | b. | Aux Hoist                                                | Refer <b>Table -1</b> above                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |
| <b>2.4.0</b> |    | Hook Approaches                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |
|              | a. | Main hook (cabin end)                                    | <b>As per Crane clearance diagram</b>                                                                                                                                                                                                                                                                                                                                                                                                |                                              |
|              | b. | Aux. Hook (cabin-end)                                    | <b>As per Crane clearance diagram</b>                                                                                                                                                                                                                                                                                                                                                                                                |                                              |
|              | c. | Main hook (other end)                                    | <b>As per Crane clearance diagram</b>                                                                                                                                                                                                                                                                                                                                                                                                |                                              |
|              | d. | Aux. Hook (other end)                                    | <b>As per Crane clearance diagram</b>                                                                                                                                                                                                                                                                                                                                                                                                |                                              |
| <b>2.5.0</b> |    | <b>Hand Rail Pipes</b>                                   | The hand railings shall consist of 32 mm NB pipe in two (2) tiers. Top pipe shall be at about one (1) m and middle pipe shall be at about 450 mm height from the walkway platform level.                                                                                                                                                                                                                                             |                                              |
| <b>3.0.0</b> |    | <b>COMPONENT DETAILS</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |
| <b>3.1.0</b> |    | <b>Trolley</b>                                           | The trolley frame shall be built up from heavy steel plates, angles and channels adequately braced to resist vertical, lateral and torsional strains, welded to form a rigid one piece frame. Alternatively, it may be of cast steel construction and should be covered by flooring as far as possible. On bottom of trolley frame, on each side a double spring bumper shall be provided to engage stops at each end of the bridge. |                                              |
|              | a. | Type                                                     | Fabricated                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |
|              | b. | Method of fabrication                                    | Fusion welded                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |
|              | c. | Material                                                 | IS: 2062 Gr. B                                                                                                                                                                                                                                                                                                                                                                                                                       |                                              |
|              | d. | Centre to centre distance of wheels (on the same rails)  | *                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                              |
|              | e. | Whether jacking pads for lifting trolley provided or not | Yes                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                              |
| <b>3.2.0</b> |    | <b>Rope drums</b>                                        | <b>Main hoist</b>                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Aux. Hoist</b>                            |
|              | a. | Dimensions in mm length                                  | During detailed engineering                                                                                                                                                                                                                                                                                                                                                                                                          | During detailed engineering                  |



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FOR  
2x660 MW UDANGUDI TPP-STAGE I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE  
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|       |    | and diameter (PCD)                             |                                                                                                                      |            |                                                           |             |
|       | b. | Material (Indicate IS)                         | Seamless pipe ASTM -106 Gr. B or fabricated rolled section Fe 410 WA IS: 2062 Gr. B & stress relieved                |            |                                                           |             |
|       | c. | Flange / flangeless                            | Flanged                                                                                                              |            |                                                           |             |
|       | d. | Numbers provided                               | One for each hoist                                                                                                   |            |                                                           |             |
|       | e. | Number of grooves                              | *                                                                                                                    |            | *                                                         |             |
|       | f. | Type of grooves                                | Identical Right hand and Left hand                                                                                   |            |                                                           |             |
|       | g. | Diameter on bottom of grooves                  | During detailed engineering                                                                                          |            | During detailed engineering                               |             |
| 3.3.0 |    | Rope details                                   |                                                                                                                      |            |                                                           |             |
|       | a. | Construction                                   | Extra flexible plough steel / 6 x 36 construction.                                                                   |            |                                                           |             |
|       | b. | Grade                                          | Rope grade 1770/1960                                                                                                 |            |                                                           |             |
|       | c. | Standard conforming to                         | IS: 2266 (latest edition)                                                                                            |            |                                                           |             |
|       | d. | Diameter in mm                                 | *                                                                                                                    |            | *                                                         |             |
|       | e. | Breaking strength                              | *                                                                                                                    |            | *                                                         |             |
|       | f. | Tensile designation                            | *                                                                                                                    |            | *                                                         |             |
|       | g. | Factor of safety                               | 5.25 as per IS                                                                                                       |            | 5.25 as per IS                                            |             |
|       | h. | Type of core                                   | Fibre                                                                                                                |            | Fibre                                                     |             |
|       | i. | Number of falls                                | *                                                                                                                    |            | *                                                         |             |
|       | j. | Length of rope                                 | *                                                                                                                    |            | *                                                         |             |
| 3.4.0 |    | Sheaves details                                | Main hoist                                                                                                           |            | Aux. Hoist                                                |             |
|       | a. | Material                                       | Fe 410 WA IS: 2062 Gr. B / CS Gr. 280-520 IS: 1030<br>Design as per IS: 3177- 1999                                   |            |                                                           |             |
|       | b. | Diameter of main sheaves in mm on Root         | During detailed engineering                                                                                          |            | During detailed engineering                               |             |
|       | c. | Diameter of Equalizing sheaves (in mm) on Root | Should not be less 62% of calculated main sheave diameter                                                            |            | Should not be less 62% of calculated main sheave diameter |             |
|       | d. | Type of guards provided                        | Fabricated from rolled steel plate                                                                                   |            |                                                           |             |
| 3.5.0 |    | COUPLINGS & SHAFTING                           |                                                                                                                      |            |                                                           |             |
| 3.5.1 |    | Coupling details (between motor and gear box)  | Main hoist                                                                                                           | Aux. Hoist | Cross Travel                                              | Long Travel |
|       | a. | Type                                           | Flexible geared type                                                                                                 |            |                                                           |             |
|       | b. | Size & Torque rating                           | *                                                                                                                    |            |                                                           |             |
|       | c. | Guards and enclosures                          | Provided                                                                                                             |            |                                                           |             |
|       | d. | Coupling material and hardness                 | All couplings shall be of cast, wrought or from forged steel, tooth portion to be heat treated to hardness HB241-280 |            |                                                           |             |
| 3.5.2 |    | Coupling details (between gear box and wheels) | Cross Travel (CT)                                                                                                    |            | Long Travel (LT)                                          |             |



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|       | a. | Type                                                     | Flexible geared type                                                                                                                                                           |                  |             |                  |
|       | b. | Size & Torque rating                                     | *                                                                                                                                                                              |                  |             |                  |
|       | c. | Guards and enclosures provided                           | Yes                                                                                                                                                                            |                  |             |                  |
| 3.5.3 |    | Coupling details (between gear box and rope drum)        | Main hoist                                                                                                                                                                     |                  | Aux. Hoist  |                  |
|       | a. | Type                                                     | Flexible joint, incorporating flexible geared coupling housed within the drum.                                                                                                 |                  |             |                  |
|       | b. | Size                                                     | *                                                                                                                                                                              |                  |             |                  |
|       | c. | Guards and enclosures provided                           | Yes                                                                                                                                                                            |                  |             |                  |
| 3.5.4 |    | Shafting (Output)                                        | Cross Travel                                                                                                                                                                   |                  | Long Travel |                  |
|       | a. | Diameter in mm                                           | *                                                                                                                                                                              |                  | *           |                  |
|       | b. | Factor of Safety                                         | As per IS: 3177-                                                                                                                                                               |                  |             |                  |
|       | c. | Number of support bearings                               | *                                                                                                                                                                              |                  | *           |                  |
|       | d. | Type of support bearing                                  | *                                                                                                                                                                              |                  | *           |                  |
|       | e. | Arrangement of lubrication                               | Grease cups / Nipple                                                                                                                                                           |                  |             |                  |
|       | f. | Type of lubricant                                        | Grease                                                                                                                                                                         |                  |             |                  |
|       | g. | Max unsupported length of shaft in mm                    | *                                                                                                                                                                              |                  | *           |                  |
| 3.6.0 |    | Gear box details                                         |                                                                                                                                                                                |                  |             |                  |
| 3.6.1 |    | Hoist Motions                                            | MH                                                                                                                                                                             | MH Micro         | AH          | AH micro         |
|       | a. | Type of mounting of gear box                             | Horizontal / Vertical                                                                                                                                                          |                  |             |                  |
|       | b. | Classification                                           | Suitable for M5 duty                                                                                                                                                           |                  |             |                  |
|       | c. | Total number of reductions                               | *                                                                                                                                                                              | Thru' VVVF drive | *           | Thru' VVVF drive |
|       | d. | Type of gears                                            | Helical                                                                                                                                                                        |                  | Helical     |                  |
|       | e. | Reduction ratio                                          | *                                                                                                                                                                              |                  |             |                  |
|       | f. | Type of lubrication (grease / splash / pump lubrication) | Splash Lubrication                                                                                                                                                             |                  |             |                  |
|       | g. | Hardness (BHN) – gear                                    | *                                                                                                                                                                              |                  |             |                  |
|       | h. | Hardness (BHN) – pinion                                  | *                                                                                                                                                                              |                  |             |                  |
|       | i. | Difference in Gear and pinion hardness                   | Min 20 BHN                                                                                                                                                                     |                  |             |                  |
|       | j. | Materials (gear/pinions)                                 | Main Gears En 9/ 55C8/ IS2707 Gr. 1or 2. Pinions En 19/EN 24. Hardness conforming to IS: 3177 (latest edition)<br>Gears to be hardened, tempered & heat treated as per IS 4460 |                  |             |                  |
|       | k. | Casings                                                  | Fabricated Fe 410w IS: 2062 Gr B & stress relieved                                                                                                                             |                  |             |                  |



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|       | l. | Noise level                                                 | 85 db                                                                                                                                                                          | NA               | 85 db                                                                     | NA               |
|       | m. | Standard conforming to                                      | IS: 4460 / AGMA                                                                                                                                                                |                  |                                                                           |                  |
| 3.6.2 |    | Travel Motions                                              | CT                                                                                                                                                                             | CT micro         | LT                                                                        | LT micro         |
|       | a. | Type of mounting gear box                                   | Vertical/<br>Horizontal                                                                                                                                                        | NA               | Vertical/<br>Horizontal                                                   | NA               |
|       | b. | Classification                                              | M5 duty                                                                                                                                                                        |                  |                                                                           |                  |
|       | c. | Total number of reduction                                   | *                                                                                                                                                                              | Thru' VVVF drive | *                                                                         | Thru' VVVF drive |
|       | d. | Type of gears                                               | Helical                                                                                                                                                                        |                  | Helical                                                                   |                  |
|       | e. | Reduction ratio                                             | *                                                                                                                                                                              |                  | *                                                                         |                  |
|       | f. | Type of lubrication<br>(grease / splash / pump lubrication) | Splash Lubrication                                                                                                                                                             |                  |                                                                           |                  |
|       | g. | Hardness (BHN) – gear                                       | *                                                                                                                                                                              |                  |                                                                           |                  |
|       | h. | Hardness (BHN) – pinion                                     | *                                                                                                                                                                              |                  |                                                                           |                  |
|       | i. | Difference in Gear and pinion hardness                      | Min 20 BHN                                                                                                                                                                     |                  |                                                                           |                  |
|       | j. | Materials (gear / pinions)                                  | Main Gears En 9/ 55C8/ IS2707 Gr. 1or 2. Pinions En 19/EN 24. Hardness conforming to IS: 3177 (latest edition)<br>Gears to be hardened, tempered & heat treated as per IS 4460 |                  |                                                                           |                  |
|       | k. | Casings                                                     | Fabricated Fe 410w IS: 2062 Gr B & stress relieved                                                                                                                             |                  |                                                                           |                  |
|       | l. | Standard conforming to                                      | IS: 4460 / AGMA                                                                                                                                                                |                  |                                                                           |                  |
| 3.7.0 |    | Wheels details                                              | Cross travel                                                                                                                                                                   |                  | Long travel                                                               |                  |
|       | a. | Material                                                    | C55 Mn 75/ En9 (55 C 8)                                                                                                                                                        |                  |                                                                           |                  |
|       | b. | Hardness                                                    | 300 – 350 BHN                                                                                                                                                                  |                  |                                                                           |                  |
|       | c. | Depth of hardness                                           | 10 mm (min)                                                                                                                                                                    |                  |                                                                           |                  |
|       | d. | Tread diameter in mm                                        | *                                                                                                                                                                              |                  | *                                                                         |                  |
|       | e. | Tread width in mm                                           | *                                                                                                                                                                              |                  | *                                                                         |                  |
|       | f. | Process of hardening                                        | Volume hardening                                                                                                                                                               |                  |                                                                           |                  |
|       | g. | Type                                                        | Double flanged                                                                                                                                                                 |                  |                                                                           |                  |
|       | h. | Numbers provided                                            | 4/8 nos.                                                                                                                                                                       |                  | 16 nos.                                                                   |                  |
|       | i. | Specification conforming to                                 | IS: 3177                                                                                                                                                                       |                  |                                                                           |                  |
|       | j  | Arrangement of lubrication                                  | Grease                                                                                                                                                                         |                  |                                                                           |                  |
| 3.8.0 |    | Lifting hooks                                               | MH                                                                                                                                                                             |                  | AH                                                                        |                  |
|       | a. | Type                                                        | Ramshorn shank with safety latch swivelling type as per latest edition of IS: 5749 for hook capacity 50T and above.<br><br>Plain with safety latch swivelling                  |                  | Plain with safety latch swiveling type as per latest edition of IS: 15560 |                  |



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|        |    |                                                                              | type as per latest edition of IS: 15560 for hook of capacity less than 50T                                                                                                                                                      |          |             |          |
|        | b. | Safe lifting capacity                                                        | Refer attached crane clearance diagrams                                                                                                                                                                                         |          |             |          |
|        | c. | Material                                                                     | <div>➤ Class 2 as per IS 1875:1992 (re affirmed 2004) for hooks conforming to IS : 5749</div> <div>➤ Class 1A or class 3 for hook of grades L &amp; M respectively as per IS 1875:1992 for hooks conforming to IS : 15560</div> |          |             |          |
|        | d. | Standard conforming to                                                       | IS: 5749                                                                                                                                                                                                                        |          | IS: 15560   |          |
|        | e. | Hook can rotate                                                              | Yes                                                                                                                                                                                                                             |          |             |          |
|        | f. | Safety latch on hook provided                                                | Yes                                                                                                                                                                                                                             |          |             |          |
|        | g. | Locking device on swivelling hook required or not                            | Provided                                                                                                                                                                                                                        |          |             |          |
| 3.9.0  |    | Buffers                                                                      | Cross travel                                                                                                                                                                                                                    |          | Long travel |          |
|        | a. | Type                                                                         | Spring loaded type. To be designed to bring the loaded crane to rest from speed of 100% of the rated speed.                                                                                                                     |          |             |          |
|        | b. | Numbers provided                                                             | 4                                                                                                                                                                                                                               |          | 4           |          |
|        | c. | Details of end stop                                                          | Mild steel, grade 'B' of IS 2062 in 100% killed, normalised and ultrasonically tested quality or high strength steel of IS 8500 as appropriate.                                                                                 |          |             |          |
| 3.10.0 |    | Brakes                                                                       |                                                                                                                                                                                                                                 |          |             |          |
| 3.10.1 |    | Hoist Motions                                                                | MH                                                                                                                                                                                                                              | MH micro | AH          | AH micro |
|        | a  | Type of brake                                                                | AC Electro-Hydraulic Thruster operated + DC electro magnetic                                                                                                                                                                    |          |             |          |
|        | b. | Diameter of brake in mm                                                      | *                                                                                                                                                                                                                               | NA       | *           | NA       |
|        | c. | Torque rating Kg. M                                                          | *                                                                                                                                                                                                                               |          | *           |          |
|        | d. | Number provided per motor                                                    | 1+1                                                                                                                                                                                                                             |          | 1+1         |          |
|        | e. | Braking capacity (% of torque transmitted to the brake drum with full load.) | 150%                                                                                                                                                                                                                            |          | 150%        |          |
|        | f. | Braking torque actually required                                             | *                                                                                                                                                                                                                               |          | *           |          |
|        | g. | Material                                                                     |                                                                                                                                                                                                                                 |          |             |          |
|        |    | • Brake liners                                                               | Ferrodol liners                                                                                                                                                                                                                 |          |             |          |
|        |    | • Drum                                                                       | CS IS : 1030 / CL 4 IS : 1875                                                                                                                                                                                                   |          |             |          |
|        |    | • Springs                                                                    | As per manufacturers standard                                                                                                                                                                                                   |          |             |          |
|        | h. | Braking distance in mm                                                       | *                                                                                                                                                                                                                               | NA       | *           | NA       |
| 3.10.2 |    | Travel Motions                                                               | CT                                                                                                                                                                                                                              | CT micro | LT          | LT micro |
|        | a. | Type of brake (ac / dc /                                                     | AC Electro-Hydraulic Thruster operated + DC electro magnetic                                                                                                                                                                    |          |             |          |



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|        |    | thrustor)                                                       |                                                                                                                                                                                                                                                                                                      |                |           |          |                    |
|        | b. | Dia of brake in mm                                              | *                                                                                                                                                                                                                                                                                                    | NA             | *         | NA       |                    |
|        | c. | Torque rating Kg.M                                              | *                                                                                                                                                                                                                                                                                                    |                | *         |          |                    |
|        | d. | Number provided per motor                                       | 1+1                                                                                                                                                                                                                                                                                                  |                | 1+1       |          |                    |
|        | e. | Braking capacity (% of motor rated torque before derating)      | 125%                                                                                                                                                                                                                                                                                                 |                | 125%      |          |                    |
|        | f. | Braking torque actually required                                | *                                                                                                                                                                                                                                                                                                    |                | *         |          |                    |
|        | g. | Material                                                        |                                                                                                                                                                                                                                                                                                      |                |           |          |                    |
|        |    | • Brake liners                                                  | Ferrodo liners                                                                                                                                                                                                                                                                                       |                |           |          |                    |
|        |    | • Drum                                                          | CS IS : 1030 / CL4 IS : 1875                                                                                                                                                                                                                                                                         |                |           |          |                    |
|        |    | • Springs                                                       | As per manufacturers standard                                                                                                                                                                                                                                                                        |                |           |          |                    |
|        |    | • Thrusters                                                     | *                                                                                                                                                                                                                                                                                                    |                |           |          |                    |
|        | h. | Braking distance in mm                                          | *                                                                                                                                                                                                                                                                                                    | NA             | *         | NA       |                    |
| 3.11.0 |    | Drive system for hoisting                                       |                                                                                                                                                                                                                                                                                                      |                |           |          |                    |
|        | a. | Arrangement of drive from motor to rope drum (main)             | Through geared coupling and gear box                                                                                                                                                                                                                                                                 |                |           |          |                    |
|        | b. | Arrangement of drive from pony motor to rope drum (creep speed) | NA                                                                                                                                                                                                                                                                                                   |                |           |          |                    |
| 3.12.0 |    | Bearings                                                        | Crane hook                                                                                                                                                                                                                                                                                           | Trolley wheels | Rope drum | Gear box | Any other assembly |
|        | a. | Type                                                            | Antifriction ball / roller bearings                                                                                                                                                                                                                                                                  |                |           |          |                    |
|        | b. | Number provided for each                                        | As per assembly requirements                                                                                                                                                                                                                                                                         |                |           |          |                    |
|        | c. | Method of lubrication                                           | Centralised grease lubrication with hand operated grease pump for all bearings as per bidder's standard proven practice.                                                                                                                                                                             |                |           |          |                    |
|        | d. | Bearing life                                                    | 10,000 working hours or 20 years whichever is earlier                                                                                                                                                                                                                                                |                |           |          |                    |
| 3.13.0 |    | Bridge girder                                                   |                                                                                                                                                                                                                                                                                                      |                |           |          |                    |
|        | a. | Type & Quantity                                                 | Box type – 2 nos. Material: Mild steel, grade 'A/B' of IS 2062 in 100% killed, normalised and ultrasonically tested quality or high strength steel of IS 8500 as appropriate.                                                                                                                        |                |           |          |                    |
|        | b. | Size                                                            | *                                                                                                                                                                                                                                                                                                    |                |           |          |                    |
|        | c. | Vertical Deflection & Camber                                    | The total maximum vertical deflections for the girder for the safe weight of working load plus the weight of crab in central position (Without taking in to consideration the impact factor) will not exceed limit of span/900.<br><br>Girders shall be cambered to an amount approximately equal to |                |           |          |                    |



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|               |    |                                                               | the dead load deflection plus one-half the live load deflection.”                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                |                 |
|               | d. | Type of connection to end carriage                            | By fitted bolts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                                                |                 |
|               | e. | Width                                                         | *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                |                 |
|               | f. | Length                                                        | *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                |                 |
| <b>3.14.0</b> |    | <b>Rails</b>                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                                                |                 |
|               | a. | Type / section                                                | Rails sections as per IS: 3443 Grade 50 C 12. Joint to be butt-welded by thermit welding & fusion welding or by end clamping method                                                                                                                                                                                                                                                                                                                                                                     |                 |                                                                |                 |
|               | b. | Standard conforming to                                        | IS: 3443                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                                                |                 |
|               | c. | Weight per metre                                              | *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                |                 |
|               | d. | Material                                                      | 50C12 or 55C11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                                |                 |
|               | e. | Top width in mm                                               | *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                |                 |
|               | f. | Height in mm                                                  | *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                |                 |
| <b>3.15.0</b> |    | <b>Type of platform required on the bridge</b>                | Chequered plate platform 6mm thick over plain as per IS : 3502                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                                |                 |
|               | a. | Length                                                        | Full span length                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                                                |                 |
|               | b. | Walkways                                                      | Platforms / walkways in crane shall be provided for maintenance with 750 mm clear inside width. Non-skid steel plate of thickness 6 mm with toe guards of 100 mm height above the floor level and safety hand railing shall be provided along the full span length on either side of the crane bridge girders. The hand railings shall consist of 32 mm NB pipe in two (2) tiers. Top pipe shall be at about one (1) m and middle pipe shall be at about 450 mm height from the walkway platform level. |                 |                                                                |                 |
|               | c. | Type of access from gantry girder level to crane bridge       | Rung ladder at ends from gantry girder level walkway to crane bridges walkway                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                                                                |                 |
|               | d. | Type of access to maintenance cage from crane bridges walkway | Rung ladder                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                                                |                 |
|               | e. | Type of access to Cabin from crane bridges walkway            | By Staircase                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                                                                |                 |
|               | f. | Provided at both ends                                         | Yes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                                                |                 |
| <b>3.16.0</b> |    | <b>End carriage span (wheel base)</b>                         | As per IS 807 (latest edition)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                                |                 |
| <b>3.17.0</b> |    | <b>Motors</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                                                |                 |
| <b>3.17.1</b> |    | <b>Hoist Motions</b>                                          | <b>MH</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>MH micro</b> | <b>AH</b>                                                      | <b>AH micro</b> |
|               | a. | Type                                                          | Three phase squirrel cage induction motors to be operated from VFD system.                                                                                                                                                                                                                                                                                                                                                                                                                              | Thru VVVF drive | Three phase squirrel cage induction motors to be operated from | Thru VVVF drive |



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FOR  
2x660 MW UDANGUDI TPP-STAGE I**

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(UPTO 100T)**

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|               |    |                                         |                                                                                                                                                                                                                                                                          |                 |                                                                                                                                                                                                    |                  |
|---------------|----|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
|               |    |                                         | Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty                                                                                                                                                   |                 | VFD system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty.                                                                |                  |
|               | b. | Enclosure                               | TEFC                                                                                                                                                                                                                                                                     | NA              | TEFC                                                                                                                                                                                               | NA               |
|               | c. | Numbers furnished                       | One per motion                                                                                                                                                                                                                                                           |                 |                                                                                                                                                                                                    |                  |
|               | d. | Voltage, phase and frequency            | 415V + 10%, 3 Ph, 3 wire, 50 Hz, $\pm 5\%$ Combined voltage & frequency variation = 10% absolute                                                                                                                                                                         |                 |                                                                                                                                                                                                    |                  |
|               | e. | Class of protection                     | IP – 55                                                                                                                                                                                                                                                                  |                 |                                                                                                                                                                                                    |                  |
|               | f. | Rated capacity (KW)                     | All drive motors will be of crane duty conforming to IS: 325 and IS: 3177. Motor nameplate rating at 50 deg C. Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed. |                 |                                                                                                                                                                                                    |                  |
|               | g. | Duration factor/duty                    | 60 % CDF / S-4                                                                                                                                                                                                                                                           |                 |                                                                                                                                                                                                    |                  |
|               | h. | Speed (rpm)                             | *                                                                                                                                                                                                                                                                        |                 |                                                                                                                                                                                                    |                  |
|               | i. | Class of insulation                     | Class 'F' for sq. cage motors with temp rise limited to that of class B                                                                                                                                                                                                  |                 |                                                                                                                                                                                                    |                  |
|               | j. | Number of starts/ hour                  | 300 starts / hr                                                                                                                                                                                                                                                          |                 |                                                                                                                                                                                                    |                  |
|               | k. | Contactors for motor                    | *                                                                                                                                                                                                                                                                        |                 |                                                                                                                                                                                                    |                  |
|               | l. | Overload protection for motors provided | Yes                                                                                                                                                                                                                                                                      |                 |                                                                                                                                                                                                    |                  |
|               | m. | Space heater requirements               | For motors of rating 30 KW and above                                                                                                                                                                                                                                     |                 |                                                                                                                                                                                                    |                  |
|               | n. | Pull out torque                         | Shall not be less than 275% of rated torque                                                                                                                                                                                                                              |                 |                                                                                                                                                                                                    |                  |
| <b>3.17.2</b> |    | <b>Travel Motions</b>                   | <b>CT</b>                                                                                                                                                                                                                                                                | <b>CT micro</b> | <b>LT</b>                                                                                                                                                                                          | <b>LT micro</b>  |
|               | a. | Type                                    | Three phase squirrel cage induction motors to be operated from VFD system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty.                                                                       | Thru VVVF drive | Three phase squirrel cage induction motors to be operated from VFD system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty. | Thru VVVF drives |
|               | b. | Enclosure                               | TEFC                                                                                                                                                                                                                                                                     | NA              | TEFC                                                                                                                                                                                               | NA               |



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|---------------|----|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------|--------------------|
|               | c. | Numbers furnished                       | 1                                                                                                                                                                                          | NA                | 2                    | NA                 |
|               | d. | Voltage, phase and frequency            | 415V + 10%, 3 Ph, 4 wire, 50 Hz, $\pm 5\%$ Combined voltage & frequency variation = 10% absolute                                                                                           |                   |                      |                    |
|               | e. | Class of protection                     | IP – 55                                                                                                                                                                                    |                   |                      |                    |
|               | f. | Rated capacity (KW)                     | All drive motors will be of crane duty conforming to IS: 325 and IS: 3177. Motor nameplate rating at 50 deg C. Motor ratings shall be 25% (at least) over the maximum power requirement.   |                   |                      |                    |
|               | g. | Duration factor/duty                    | 60 % CDF / S-4                                                                                                                                                                             |                   |                      |                    |
|               | h. | Speed (rpm)                             | *                                                                                                                                                                                          |                   |                      |                    |
|               | i. | Class of insulation                     | Class 'F' for sq. cage motors with temp rise limited to that of class B                                                                                                                    |                   |                      |                    |
|               | j. | Number of starts/ hour                  | 300 starts / hr                                                                                                                                                                            |                   |                      |                    |
|               | k. | Contactors for motor                    | *                                                                                                                                                                                          |                   |                      |                    |
|               | l. | Overload protection for motors provided | Yes                                                                                                                                                                                        |                   |                      |                    |
|               | m. | Space heater requirement                | For motors of rating 30 KW and above                                                                                                                                                       |                   |                      |                    |
|               | n  | Pull out torque                         | Shall not be less than 275% of rated torque                                                                                                                                                |                   |                      |                    |
| <b>3.17.3</b> |    | Motor Duty and pullout torque           | Duty S4 and pullout torque 275% of full load torque                                                                                                                                        |                   |                      |                    |
| <b>3.18.0</b> |    | <b>Limit switches</b>                   | <b>Main hoist</b>                                                                                                                                                                          | <b>Aux. hoist</b> | <b>Cross Travel</b>  | <b>Long Travel</b> |
|               | a. | Type                                    | Rotary gear + Gravity                                                                                                                                                                      |                   | Lever type (two way) |                    |
|               | b. | Number provided                         | 1+1                                                                                                                                                                                        | 1+1               | 1                    | 1                  |
|               | c. | Rating of contacts                      | *                                                                                                                                                                                          |                   |                      |                    |
|               | d. | Material of contacts                    | Double break Silver Cadmium                                                                                                                                                                |                   |                      |                    |
|               | e. | Control voltage / Enclosure             | 110 V/ IP 55                                                                                                                                                                               |                   |                      |                    |
| <b>3.20.0</b> |    | <b>Power conductors (DSL)</b>           |                                                                                                                                                                                            |                   |                      |                    |
|               | a. | Type                                    | LT: PVC shrouded Cu conductor bus bar.<br>CT: Flexible trailing cable mounting on retracting support (Festoon type) ERP insulated Cu conductor as per IS:9968                              |                   |                      |                    |
|               | b. | Size                                    | Shall be sized with a margin of 20% over load requirement. Voltage drop at motor terminal shall be limited to 3% at extreme positions of cranes. Protective cover over DSL to be provided. |                   |                      |                    |
|               | c. | Length                                  | Suitable for bay length                                                                                                                                                                    |                   |                      |                    |
|               | d. | Guard provided                          | Yes                                                                                                                                                                                        |                   |                      |                    |
| <b>3.21.0</b> |    | <b>Protective Panel</b>                 | 20 % spare terminals to be provided in panel                                                                                                                                               |                   |                      |                    |
|               | a. | Size                                    | *                                                                                                                                                                                          |                   |                      |                    |
|               | b. | Material                                | Sheet steel 2 mm size                                                                                                                                                                      |                   |                      |                    |
|               | c. | Numbers and location                    | One number located in cabin                                                                                                                                                                |                   |                      |                    |



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|               | d. | DOP                                         | IP 55                                                                                                                                                                                                                                                                                     |                                  |
| <b>3.22.0</b> |    | <b>Control panel</b>                        | 20 % spare terminals to be provided in panel                                                                                                                                                                                                                                              |                                  |
|               | a. | Size                                        | *                                                                                                                                                                                                                                                                                         |                                  |
|               | b. | Material                                    | Cold Rolled sheet steel 2mm size                                                                                                                                                                                                                                                          |                                  |
|               | c. | Numbers and location                        | One each for MH, AH, CT and LT located on bridge platform with space heaters.                                                                                                                                                                                                             |                                  |
|               | d. | Degree of protection                        | IP 55                                                                                                                                                                                                                                                                                     |                                  |
| <b>3.23.0</b> |    | <b>Maintenance cage</b>                     | Suitable inspection cages to accommodate two persons to facilitate inspection of down shop lead.                                                                                                                                                                                          |                                  |
| <b>3.24.0</b> |    | <b>Control for Hoists /CT/LT operations</b> | Through Variable Voltage Variable frequency drive                                                                                                                                                                                                                                         |                                  |
|               | a. | Speed control                               | Thru' VVVF with 1024 pulse incard, droop control for synchronization and crane software.                                                                                                                                                                                                  |                                  |
|               | b. | Rating of VVVF                              | The rating of VVVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.                                                                                                                |                                  |
|               | c. | Duty                                        | Continuous duty as per IEC 146 (clause II).                                                                                                                                                                                                                                               |                                  |
|               | d. | Output frequency range                      | Shall be minimum 0 to 50 Hz at constant torque and 0 to 100 Hz at constant power.                                                                                                                                                                                                         |                                  |
|               | e. | Efficiency                                  | Minimum 97%.                                                                                                                                                                                                                                                                              |                                  |
|               | f. | General                                     | Individual converters shall be provided for each vector drive. The harmonic content reflected on incoming line is to be limited to 5% THD and 3% for individual harmonics. Harmonics filters preferably along with 12 pulse converter/IGBT based converter shall be used to achieve this. |                                  |
| <b>3.25.0</b> |    | <b>Cable</b>                                | <b>Power</b>                                                                                                                                                                                                                                                                              | <b>Control</b>                   |
|               | a. | Material                                    | Copper                                                                                                                                                                                                                                                                                    | Copper                           |
|               | b. | Type                                        | Power cables shall be XLPE insulated. Control cables shall be PVC / XLPE insulated. All cables shall be armoured.                                                                                                                                                                         |                                  |
|               | c. | Size                                        | Min. 2.5 mm <sup>2</sup> for Cu.                                                                                                                                                                                                                                                          | Min. 1.5 mm <sup>2</sup> for Cu. |
|               | d. | Voltage grade                               | 1100 V                                                                                                                                                                                                                                                                                    |                                  |
|               | e. | Voltage drop                                | Cable from main isolating switch (1.5M above operating floor) to motor terminal shall be so sized that the voltage drop does not exceed 3% of rated voltage at motor terminals.                                                                                                           |                                  |
| <b>3.26.0</b> |    | <b>Earthing</b>                             |                                                                                                                                                                                                                                                                                           |                                  |
|               | a. | Material of earthing                        | G.I / Copper                                                                                                                                                                                                                                                                              |                                  |
|               | b. | Earthing as per specification               | Yes                                                                                                                                                                                                                                                                                       |                                  |
| <b>3.27.0</b> | a. | <b>Contactors</b>                           | AC 4 duty for reversing application. AC 3 duty for non-reversing application                                                                                                                                                                                                              |                                  |
|               | b. | <b>Switches</b>                             | AC 23 for motor application, AC 22 for other application.                                                                                                                                                                                                                                 |                                  |
|               | c. | <b>Fuses</b>                                | HRC                                                                                                                                                                                                                                                                                       |                                  |
|               | d. | <b>Overload relay</b>                       | Temperature compensated bi metallic with single phasing preventor.                                                                                                                                                                                                                        |                                  |
| <b>3.28.0</b> |    | <b>Power supply</b>                         | Owner shall provide one (1) no. 415 V, 3 phase, 3 wire supply at                                                                                                                                                                                                                          |                                  |



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|---------------|----|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |    |                                                    | operating floor near A row column at centre of bay length shall be provided. Bidder shall provide change over switch in enclosure to receive above power supply. |
| <b>3.29.0</b> |    | <b>Transformer</b>                                 |                                                                                                                                                                  |
|               | a. | Quantity                                           | 2 X 100 % for control, 1 no for lighting & 1 no for hand lamp.                                                                                                   |
|               | b. | Voltage Rating                                     | Control 415/110V, Lighting 415/240V and hand lamp 415/24V.                                                                                                       |
|               | c. | KVA rating                                         | 20% over loading to be considered while sizing the rating                                                                                                        |
| <b>3.30.0</b> |    | <b>Illumination</b>                                |                                                                                                                                                                  |
|               | a. | Over Bridge                                        | 4 Nos. 10W LED Bulkhead Walkway light and 4nos. 3 pin industrial socket                                                                                          |
|               | b. | Under bridge                                       | 2 nos 250 W HPSV lamps for other double girder cranes                                                                                                            |
|               | c. | For inspection of crane components                 | One (1) portable 40W SLS hand lamp with enclosed type battery and wire guard with min. half span length flexible cable for inspection of crane components        |
|               | d. | Hand lamp socket and hand tool sockets             | Hand lamp socket outlets (2 pin, 10A, 24V) and power socket outlets (3 pin, 20A, 240V) shall be provided for use of hand tools along with switches.              |
| <b>3.31.0</b> |    | <b>Fire Extinguisher</b>                           |                                                                                                                                                                  |
|               | a. | Type and size                                      | 4.5 kg CO <sub>2</sub> type                                                                                                                                      |
|               | b. | Location                                           | Two on bridge                                                                                                                                                    |
| <b>3.32.0</b> |    | <b>Type of control for Hoists/ CT/LT operation</b> | Through VVVF drive                                                                                                                                               |
| <b>3.33.0</b> |    | <b>Load cell</b>                                   | For overload protection of hoisting motion                                                                                                                       |

**Note: Other requirements for the system.**

- Centralized grease lubrication with hand operated grease pump for all bearings.
- All materials / components will be new and of tested quality and will conform to the specification requirements and standards mentioned.
- No cast iron parts will be used on the crane except for electrical motors and gearbox castings. Similarly no wood or other combustible material will be used in any part of the crane.
- The crane electrical shall be designed for ambient air temperature of 50 Deg. C relative humidity of 100%. The equipment shall operate in highly polluted environment.
- All electrical equipment, accessories and wiring shall have tropical protection involving special treatment of insulation and metal against fungus, insects and corrosion.
- Emergency Switch-Mushroom type emergency STOP push buttons to open the main contactor shall be furnished at least one in operator's cabin and two on bridge platform within easy reach.
- DSL phase indicating lamps to be provided.
- Pull out torque of motor at rated voltage shall be 275% of full load torque.



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**SECTION-II**

**SPECIFIC TECHNICAL REQUIREMENT**

**SUB-SECTION IIA**

**STANDARD TECHNICAL REQUIREMENT  
(MECHANICAL)**



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**SUB SECTION-IIA**

**STANDARD TECHNICAL REQUIREMENT (MECHANICAL)**



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**DOUBLE GIRDER EOT CRANE**

**1.0.0 SCOPE**

This specification covers the design, material, manufacture, assembly, inspection and testing at manufacturer works for EOT cranes and shall be applicable unless the requirements are addressed otherwise in BHEL / BHEL's Customer approved documents.

**2.0.0 CODES AND STANDARDS**

The equipment to be supplied under this specification shall conform to the following codes and standards (latest revisions) unless otherwise specified hereinafter.

- |       |                  |                                                                                                           |
|-------|------------------|-----------------------------------------------------------------------------------------------------------|
| i)    | IS 807           | Codes of Practice for Design, Manufacture, Erection and Testing (Structural Portion) of cranes and hoists |
| ii)   | IS: 3177         | Code of Practice for Design of Overhead Travelling Cranes and Gantry Cranes other than steel work cranes. |
| iii)  | IS: 2266         | Specification for steel wire ropes for general Engineering purposes.                                      |
| iv)   | IS: 4029         | Guide for testing induction motor (for temperature rise).                                                 |
| v)    | IS: 15560        | Steel hooks for standard shank design.                                                                    |
| vi)   | IS: 3443         | Specification for crane rail section.                                                                     |
| vii)  | IS: 325          | Three phase induction motors.                                                                             |
| viii) | IS: 900          | Code of practice for installation and maintenance of induction motors.                                    |
| ix)   | IS: 4237         | General requirement of switchgear and Control gear for voltage not exceeding 1000V.                       |
| x)    | IS: 434 (Part I) | Copper conductors rubber insulated cables for voltage up to 1000V.                                        |
| xi)   | IS 1596          | Polyethylene insulated PVC sheathed cables                                                                |
| xii)  | IS 3043          | Code of practice Earthing                                                                                 |
| xiii) | IS: 3938         | Electric Wire Rope Hoists.                                                                                |
| xiv)  | IS: 2147         | Degree of protection provided by enclosures for Low voltage switchgear and control gear.                  |
| xv)   | IS: 1554 Part I  | PVC insulated (Heavy-duty) electric cables for working voltages up to and including 1100 volts.           |
| xvi)  | IS: 691          | Flexible trailing cables rubber insulated.                                                                |



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| xvii)   | IS: 1653          | Steel conduits for general engineering purposes.                                                            |
| xviii)  | IS: 2509          | Rigid non-metallic conduit for electric-Installations                                                       |
| xix)    | IS: 2062          | Steel for General Engineering purposes.                                                                     |
| xx)     | IS: 1030          | Carbon Steel castings for general engineering purposes.                                                     |
| xxi)    | IS: 1570          | Schedules for Wrought steels.                                                                               |
| xxii)   | IS: 1875          | Carbon steel billets, blooms, slabs and bars for forgings.                                                  |
| xxiii)  | IS: 808           | Dimensions for hot rolled steel beam, column, channel and angle sections.                                   |
| xxiv)   | IS: 1852          | Rolling and cutting tolerances for Hot rolled steel products.                                               |
| xxv)    | IS: 2291          | Tangential Keys and Keyways.                                                                                |
| xxvi)   | IS: 2292          | Taper Keys and Keyways.                                                                                     |
| xxvii)  | IS: 3961          | Recommended current rating for cables.                                                                      |
| xxviii) | IS: 694           | PVC insulated cables for working voltages up to and including 1100V)                                        |
| xxix)   | IS: 1554 (part-I) | PVC insulated (heavy duty) electric cables:<br>Part 1: for working voltages up to and including 1100 volts. |
| xxx)    | IS: 4289          | Flexible cables for lifts and other flexible connections:<br>Part 1: Elastomer insulated cables.            |
| xxxi)   | BS: 970           | Wrought steels in the form of blooms, billets, bars and forgings.                                           |
| xxxii)  | IS: 5749/ BS 3017 | Specification for Forged Rams horn Hooks                                                                    |

**Indian electricity rules - 1956.**

In the event of any conflict between the specification and standards mentioned above, the more stringent of the two as per interpretation of purchaser shall govern.

**3.0.0 DOUBLE GIRDER EOT CRANE**

**3.1.0 DESIGN REQUIREMENTS**

3.1.1 The crane shall be designed in accordance with the latest edition of IS-3177, IS-807 and any other standard as referred there in and subject to any modification and requirement as specified herein after.

Class of crane mechanism shall correspond to that of the crane requirement and as specified elsewhere.



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- 3.1.2 Safety devices should be provided with all equipment/parts covered under this specification.
- 3.1.3 Parts requiring replacement or lubrication shall easily be accessible without dismantling the other equipment or structures. All electrical cables shall be laid to comply with recognized standards and purchaser's requirements.
- 3.1.4 For welded construction such as bridge girders, end carriages, rope drum, gearboxes etc. steel shall be conforming to IS-2062 quality. Welding shall be carried out only by qualified welders and subjected to NDT as specified in Quality Plan.
- a. Welding shall be performed by shielded electric arc, gas or other approved methods. The electrodes used for welding shall conform to AWS A5.1.
  - b. Wherever lateral welding of the main plates of box girders are required, it shall be butt-welded.
  - c. Qualification of welding procedure and welder: These shall be carried out as per ASME Boiler and Pressure vessel code Sec. IX - Welding and brazing qualifications.
  - d. Electrode designations and qualifications shall be as per AWS A 5.1.
  - e. Electrodes should be of radiography quality with heavy covering as per IS: 814 and relevant requirement of ASME Sec IX and IIC.
  - f. Bare electrodes as per IS: 7280 and flux wire combination as per IS: 3613.
- 3.1.5 No cast iron part shall be used on the crane and its accessories.
- 3.1.6 Guard shall be provided on crane to prevent the hoist ropes coming in contact with down shop leads. Guards/ rail sweep of an approved design, which will push forward or off the track any object such as a person foot or arm, placed across it. Guards shall be attached to each end of the end carriages. Suitable guards shall be provided to revolving shafts, coupling etc.
- 3.1.7 All cables shall be clamped individually. All trailing cables shall be clamped with PVC or non-metallic clamp.
- 3.1.8 Walkways of CT shall be of chequered plate minimum 6 mm thick O/P at least 800 mm clear inside with non-skid toe plates 8mm thick, projecting 100 mm above the floor. Walkways shall be of rigid construction and designed to sustain a distributed load of not less than 300 kg/ sq. mm. Intermediate posts for supporting handrails shall not be spaced more than 1.5 meters apart. Ladders provided shall have at least 450mm clear width with 20 mm rungs (rods) spaced 300 mm apart.
- 3.1.9 All wheels, couplings, open gear etc. shall be provided with covers.
- 3.1.10 All bolts except those with locknut shall be provided with grip lock nuts or spring washers.
- 3.1.11 Fasteners for pedestal blocks, motors, gearboxes etc. shall be easily removable from the top. Studs shall not be used as fasteners for mechanical items except for fixing covers.



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- 3.1.12 Defects in the material like fractures, cracks, blowholes, pitting etc. are not allowed. Rectification of any such flaw is permissible only with the approval of the purchaser.
- 3.1.13 All parts of the crane shall be thoroughly cleaned of mill scales, rust or foreign matter and then painted as per the specification requirements.
- The permissible camber shall be shown in drawing or data sheet submitted for approval.
- 3.2.0 **STRUCTURAL DETAILS**
- 3.2.1.0 Crane structure shall be designed in accordance with the latest edition of IS-807 after taking the following additions/deviations as applicable.
- 3.2.1.1 Black bolts shall not be used in the main structure of the crane. The calculated strength of other bolted joints in structural members shall not be less than net strength of member plus 25%.
- 3.2.1.2 The calculated strength of riveted joint or joints made by friction grip bolts in structure members shall be not less than the calculated net strength of the member.
- 3.2.1.3 Bolts used in shear shall be fitted in to reamed hole.
- 3.2.1.4 Nuts and Bolts will be as per IS:1363, IS: 1364 and IS: 1367. High-tension friction grip bolts as per IS: 3757 and High- tension friction grip nuts as per IS: 6623.
- 3.2.1.5 Transverse filled welding on load carrying member shall be avoided.
- 3.2.1.6 All butt welds on structural members subjected to tensile stress shall be of radiographic quality as ASME Sec VIII Div.1 acceptance norms.
- 3.2.1.7 Fillet welding on load carrying members shall be avoided.
- 3.2.1.8 For load carrying members the component plates, bars, angles and other rolled sections shall be minimum 8mm thick. For tubes having both ends sealed the minimum thickness shall be 6 mm. For unsealed tubes the minimum thickness shall be 8mm.
- 3.2.1.9 The cranes working out door or in corrosive environment, an allowance of 1.5 mm shall be added to the calculated thickness.
- 3.2.1.10 Minimum thickness of chequered plates for platform shall be over 6 mm over plain. Chequered plates shall not be considered for strength calculations of load carrying members.
- 3.2.1.11 Splice shall be designed to resist all the forces and moments to which it is subjected to plus 50% thereof.
- 3.2.1.12 However, in no case the strength developed by the splice shall be less than 50% of the effective strength of the material spliced. Splices shall be proportioned and arranged, so that the gravity axis of the splice in line with the gravity axis of the member joined so as to avoid the eccentricity of the loading.



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- 3.2.1.14 The material of construction of the major components shall be as specified in the specification/data sheet. Manufacturer are however free to use alternate material which are superior for the intended service. But in all the cases, prior concurrence of the purchaser is must.
- 3.2.1.15 Splices shall be designed to resist one and half times the forces and moments to which it is subjected, but in no case it shall be less than 2/3rd of the effective strength of the material spliced except that splices in the webs of the plate girders shall be designed for full strength of the web in shear as well as bending. For splicing tension members, the net section of the splice plate shall be ten percent more than that of the material spliced. Splices shall be proportioned and arranged, so that the gravity axes of the splices are in line with the gravity axis of the member to avoid eccentricity.
- 3.2.2 **Bridge Girder**
- 3.2.2.1 The bridge girder shall consist of a box construction with double Web plate girders or lattice girders and shall be of adequate strength to withstand the rolling loads and other stresses it is subjected to. The design of the girder shall be in accordance with latest edition of IS- 807.
- 3.2.2.2 Maximum deflection of the bridge girder, with safe working load, shall not exceed 1/900 of the span or as per latest IS. The girder shall be supported on the centerline of LT wheels during the deflection check. The girder shall be cambered by an amount by an amount equal to the maximum deflection.
- 3.2.2.3 Box section shall be adequately reinforced by internal diaphragms and ribs to withstand the most severe combination of load that may develop under different working conditions. Additional Internal diaphragms shall be provided at points where external members are welded for providing support to drives etc.
- 3.2.2.4 Box girders shall be provided with end plates sealing. Diaphragms inside the girder shall extend to the full - width & depth of the girder and the web plates shall be reinforced by angles all along the full length of the plates spaced midway between the diaphragms. Full depth diaphragms or stiffeners shall be furnished at bridge drive supports and below the line shaft bearings.
- 3.2.2.5 Short diaphragms shall be furnished and are required to transmit the trolley wheel loads to the web plates. Trolley rail section shall not be considered into design of bridge girders.
- 3.2.2.6 Full length chequered platforms on both side shall be provided on the side of bridge girders as specified in data sheet - A.
- 3.2.2.7 There should not be accumulation of water/oil inside the box girders. If required breathing holes can be provided for expansion / contraction, due to change in temperature. Tapped (threaded) holes shall be provided with ½" NPT plug in the bottom of the girders, at both ends, to drain off any accumulation of water / Oil inside the girder. Instruction shall be painted on the girders to remove the plug and check for water/oil before lifting. Plug shall be replaced after installation.



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- 3.2.2.8 All connection splices shall be designed for full strength of member of loads indicated unless otherwise approved. Beams and connections shall be designed for 60% of shear capacity of beam section plus additional axial load if any. Not more than one splice shall be provided to make up full length of member.
- 3.2.2.9 Maximum Span/ Depth ratio for Girder
- Plate Girder : 18
  - Lattice Girder : 12
- 3.2.3 **End carriage**
- 3.2.3.1 End carriages shall be fabricated from rolled steel section or plates. End carriage shall be of ample strength to resist all stresses likely to be imposed on them under service conditions including collision with other cranes or stops. The length of the end carriages shall be such that no other part of the crane is damaged in collision. End carriage shall be so designed as to distribute the load evenly between the wheels from each bridge girders.
- 3.2.3.2 The wheel base shall not be less than 1/5th of the span. End carriage shall be fitted with safety stop to prevent the end carriage falling more than 25 mm in the event of breakage of a track wheel, bogies or axle.
- 3.2.3.3 Suitable jacking pads at a suitable height from rail level shall be provided on each crane for crane jacking. Jacking pad dimensions shall be suitable for full seating of the jacking pad seat without any instability. When changing the track wheel, jacking pads shall not interfere with replacement of track wheel.
- 3.2.4 **Crab (Trolley)**
- 3.2.4.1 The crab frame shall be built from heavy steel section, welded properly to form single piece frame & to resist vertical, lateral and torsional strain and to support all loads without undue deflection. It should be properly machined to receive hoisting mechanism, cross traverse arrangement/mechanism, wheels etc. etc.
- 3.2.4.2 Sheaves, part of hoisting mechanism, shall be so arranged on trolley that rope reeling arrangement shall ensure lifting of load in vertical line with minimum of swing or side movement. Trolley shall be provided with chequered plates all over except for opening required for ropes and equipment foundation. Equipment foundation shall not be welded/ supported on chequered plates. Toe plates 100 mm high and 6mm thick shall be provided around opening provided for movement of ropes. Suitable railing shall also be provided around the opening for rope in case the opening is large.
- 3.2.4.3 Platforms and Ladders



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a) Safe means of access shall be provided to every place where any person engaged in the examination or maintenance of the crane has to work. Adequate handholds and footholds shall be provided as necessary..

b) Every platform shall be provided with steel chequered plate top and be securely fenced with 1050 mm high double tier hand rails and toe boards. Platforms shall be of sufficient width to enable normal maintenance work to be undertaken safely

c) Safety hand railing of tubular construction 32 mm NB Medium class of IS: 1239 having top and bottom rail at height of 1100 mm and 600 mm and vertical post spacing not exceeding 1750 mm with provision of kick plate (100 mm high and 6mm thick) shall be provided on bridge walkways and on end carriages, staircases, trolley and at any other place where access is provided. Bends shall be neat and made by machine. The top rail should be so laid that there is no intermediate obstruction and hand need not be lifted from rail while walking

d) In case lattice riveted construction is offered for the bridge girder, full length chequered plate platform with adequate headroom shall also be provided at bottom chord level for periodic checking of all rivets/bolts and other items.

3.2.5.0 Brief description of crane operation, Maintenance and periodical lubrication etc. typed in English and in local language neatly framed in a permanent frame for easy reference.

3.2.6.0 Suitable inspection cages to accommodate two persons to facilitate inspection of DSL.

### 3.3.0 **MECHANICAL**

#### 3.3.1 **Rope drums**

Rope drums shall be of mild steel plate fabricated/ cast steel/ as per IS 3177. All fabricated rope drums shall be stress relieved. The drum shall be so designed to take full length of hoisting rope in single layers. The end of the rope shall be anchored to the drum in such a way that the charger in readily accessible. Each rope shall have not less than two (2) full turns on the drum when the hook is at lowest position not taking into consideration the turns covered by the rope in charge. One spare groove shall be provided for each rope drum when the hook is at the highest position. Each rope end shall be clamped with minimum two clamping wedges with at least two bolts on each clamping arrangement.

The pitch diameter of the drum shall be as per IS - 3177 or as specified elsewhere. The depth of the groove shall not be less than 0.35 times the rope diameter. Each rope shall be clamped to drum with two clamp wedges with at least two numbers of bolts on each clamping arrangement.

For evaluation of Radiography the designed thickness of the drum (top of crest to ID) shall be taken into consideration and not the thickness of plate selected.



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**3.3.2 Hoist ropes**

Ropes of steel core as specified in Data sheet "A" shall be of 6x36 or 6x37 construction of extra flexible plough steel as per IS 2266 having minimum UTS of 1770 kN.

**3.3.3 Rope sheaves**

Sheaves shall be of cast (Castings to IS: 1030 Gr. II with Y.P. greater than 50% of UTS) or forged steel. All sheaves shall be identical, however, exception may be made for equalizer sheave. Sheave groove shall be ground finished for getting increase rope life. Equalizer sheave shall be arranged to turn and swivel in order to maintain rope alignment under all circumstances.

**3.3.4 Wheels**

LT & CT wheels shall be double flanged with straight tread. The wheels shall be capable of taking up misalignment in span as specified. Solid wheel shall either be of forged steel or as specified in Data sheet. The wheel rim shall be with minimum hardness of BHN 300-350. Wheels may be either hardened on tread portion as per IS -3177 or Volume hardened. Contact stresses between wheels and rails should be within permissible limits.

**3.3.5 Buffer**

Each End carriage shall be provided with buffer as per data sheet 'A'. Buffers should be so located that removal is not required while changing wheels or bogies. Buffers shall have sufficient tension on energy absorption capacity to bring the unloaded crane to rest from the speed of 100% of the rated speed to zero speed. Buffer is to be fitted to each end of carriage assembly and crab so that buffer contact takes place before the bridge or trolley reaches the end of rail.

**3.3.6 LT drive**

The bridge motion shall be achieved by suitable drive arrangement as specified elsewhere. When twin drives are used, these shall be operating in unison to avoid skewing effect. The drives shall be interlocked for simultaneous starting, stopping & speed control.

**3.3.7 CT drive**

Trolley drive shall be achieved by suitable drives & power shall be transmitted to the geared wheel by means of pinions mounted on both ends of the output shaft.

**3.3.8. Gearing**

**3.3.8.1** Gears in speed reducer unit for bridge drive, hoists and trolley drive gearing shall be enclosed in substantial housing and shall operate in oil bath. The housing shall be of sufficient design not to permit temperature in excess of 90°C for the oil bath. Spur and helical gearing shall normally be used for all motions. Worms and bevel gears shall not be used. First high-speed reduction shall be through helical gears. All gears shall be hardened and tempered and of alloy steel with machine cut teeth 1.6



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Micron finish or better and lapped with some minimum applied load to remove high spots and to improve tooth contact. Cast alloy steel is acceptable only for gears in the last stage of speed reduction. Surface hardening of teeth is not acceptable. Gear teeth shall preferably be cut in metric module system. Gears shall be designed to meet requirement of crane duty as per IS: 3177. The ratings of gears shall be established as per IS: 4660.

**3.3.9 Gear Box**

**3.3.9.1** All gears shall be completely covered and enclosed in oil tight casing & sealed with gasket. In case of totally enclosed gearboxes, splash or automatic lubrication system shall be used. Covers shall be split horizontally at each shaft centre line, so that top half can be removed for inspection and repair with out disturbing the bottom half. Gear shafts shall be supported on ball/roller bearings mounted in gearbox unless specially agreed otherwise. The gear boxes shall be provided with breather, air vent, oil level indicator, dip stick, drain plug and lugs for lifting.

Radial clearance between the gear boxes inner surface and outside diameter of the gears shall be at least 1.25 times the depth of larger gear tooth inside the gear box or 20mm which ever is higher. Facial clearance between inner surface of gearbox and face of gear or pinion shall be at least 20 mm. Gearbox shall be inspected in line with QP and as per PEM (Q)/001 enclosed.

**3.3.9.2** The gearboxes shall be of mild steel or cast steel. All fabricated gearboxes shall be stress relieved at a temperature between 590 to 680 deg. C. The temperature shall be maintained within  $\pm 20$  deg. C and at no time during the soaking cycle the temperature shall fall below 590 deg. C or exceed 680 deg. C. Soaking shall be done for a period proportionate to 1 (one) hour/ 2.5 cm. of wall thickness.

**3.3.10 Bearing**

**3.3.10.1** Ball and roller antifriction bearing of attached sub-vendor list, make shall be used throughout, except where specified otherwise. Drive side bearing on Hoisting equipment shall be ball / roller bearing type. Rated life of ball and roller bearing shall be not less than total working life as per data sheet-A. Life of bearing shall be calculated in accordance with manufacturer's recommendations.

**3.3.10.2** Provision shall be made for service lubrication of all bearings. Lubrication arrangement and clamping shall be done neatly. Bends in pipe shall be done with the help of machine. Bearing enclosures shall be designed as far as practicable to exclude dirt and shall prevent oil leakage. Accessibility should be such that parts may be safely lubricated from the walkway or ladder when the crane is not in motion.

**3.3.11. Shafts, Couplings and axles**

**3.3.11.1** Shafts and axles shall be made from solid rolled or forged steel bars and shall have ample strength and rigidity and adequate bearing surface. If shouldered, they shall be provided with fillets of ample



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radius and /or be tapered to avoid stress concentration.

Motor shafts shall be connected to gearbox input extension shafts through flexible gear coupling. Solid coupling shall be used for connecting intermediate lengths of long travel shafts. For driving hoist drum full-gear couplings shall be used between hoists drum & hoist gearbox output shaft. Couplings shall be of cast steel/wrought steel conforming to IS: 1030 grade 280-520 and shall be designed to suit service conditions.

3.3.11.2 Self-aligning type gear couplings shall be used between connection shafts to take care of transverse as well as axial movement whenever necessary. Whenever components of considerable amount of inertia are directly mounted on the high-speed shaft (e.g. brake drum, coupling etc.) they shall be balanced statically to minimise vibration.

**3.3.12 Repair Cage**

A repair cage shall be provided on the inside of the end carriage for attending the main current collectors. The repair cage shall be adequately sized to accommodate two persons. And guarded for safety and correctly located for the intended service. Suitable access to the cage shall be provided. Repair cage shall be provided at the corner of the crane.

**3.3.13 Lifting hook**

Standard hooks shall be used unless otherwise specified. These hooks shall conform to the latest edition. All hooks used shall be in normalized condition only.

**3.3.14 LIFTING HOOK BLOCK ASSY**

3.3.14.1 Lifting hook block assembly shall be Ram shorn type or approved for capacity greater than 50 Tonnes and point hook with Shank for capacity below 50 Tonnes and shall be of forged steel construction. Hooks shall be manufactured from Blooms, billets, rounds by forging with forging ratio of at least 3:1. Hooks manufactured from plates are not acceptable. All hooks used shall be in normalized condition only. Each hook shall be supported on ball or roller thrust bearing and shall rotate freely.

3.3.14.2 The sheaves of the hook block shall be enclosed in a casing permitting generous lubrication of wire ropes, sheaves and also preventing accidental tapping of hands.

**3.3.15 Brakes**

3.3.15.1 Selection and design of brakes shall be such as to meet the requirement. Brakes shall be designed to suit 150% of torque transmitted to the brake drum with full load for hoist motions and 125% of motor rated torque before de-rating for LT/CT motion. Brakes shall be provided as specified in Data Sheet 'A'. Brake drum shall be separately mounted and coupling halves shall not be used as brake drum.

**i) SERVICE BRAKE**



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Double shoe types & disc type service brakes shall be provided for each motion of the crane as/or as specified in Data Sheet. The service brakes shall apply automatically when power supply to the drive motor is cut off or fails.

**ii) HOIST CONTROL**

Hoist motion shall be provided with a self-contained sturdy braking system to control the speed of hoisting as well as lowering motion. The braking system shall be reasonably uniform and effective in all loads at any position.

**3.4.0 ELECTRICAL**

**3.4.1** The scope of supply shall cover all electrical equipments comprising from Main isolating switch, down shop leads, trolley conductors, current collectors etc.

**3.4.1.1** Main Disconnecting/Isolating Switch fuse unit shall be provided at 1.5M above the operating floor level at one end / at both the ends of bay length or in the middle as specified in the data sheet A. Termination of incoming power supply cable to isolating switch fuse unit and further cable from switch to down shop leads shall be included in the bidder's scope of work. The switch shall be provided with Power ON Red indication lamp.

**3.4.1.2** Run way conductors (Down shop leads) shrouded conductor as specified in the data sheet A shall have four conductors. One of the conductors shall be connected to earth grid for earthing connections of all electrical equipment on the crane and shall be connected to suitable collecting gear of earth conductor. Voltage drop across the down shop leads shall be less than 2% or specified in data sheet "A". It shall be supplied with brackets. Maintenance cage for DSL shall be provided on crane.

**3.4.1.3** The current collectors shall be with adequate current carrying capacity and shall maintain adequate contact pressure. Spacing between current collectors shall be such as to provide sufficient quenching area for sparks coming out of collectors surface. The collector system per conductor shall spring loaded CI/carbon metallic shoes to maintain adequate contact pressure.

**3.4.1.4** The cable, supplying power to crane trolley shall be flexible trailing cable as per IS-9968 Part I (latest edition) and mounted on retracting supports (festoon type).

**3.4.2 DRIVE MOTORS**

**3.4.2.1** Crane Motors shall be totally enclosed, fan cooled and as per data sheet 'A'. The starting torque of motor shall not be less than 2.25 times the rated torque and pull out torque shall not be less than 275% of the rated full load torque of motor.. In case of VVVF drive system, the creep speed will be achieved through VVVF drives and the motors for Main hoists, Auxiliary hoist, CT and LT will be



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Squirrel cage. Hoisting drive motors shall be provided with antifriction roller / ball bearings on the drive side.

3.4.2.2 Ambient correction factors as well as voltage /frequency correction factors depending up on the ambient temperature and voltage /frequency variation shall be applied to de-rate the motors. The minimum margin of 10% shall be considered over the calculated rating of the motor. The protection class of the motors shall be as IP-55. Motors shall be tested at manufacturer's works in accordance with IS-325/as per agreed Quality plan & Reports shall be submitted for approval. Motors shall comply with the requirement of IS-325 or as per the motor spec.

3.4.2.3 All the motors shall be provided with lifting lugs two earth terminals of adequate size to accept the earthing conductors shall be provided at diametrically opposite points unless specifically designed For higher speeds, motors shall be capable of with-standing 2.5 times the rated speed.

3.4.2.4 Motors shall be painted in line with painting instructions specified in Painting Scheme Annexure IV attached along with the technical specification.

**3.4.3 Limit switches**

The hoist mechanism of the crane shall be provided with rotary type limit switch to open the control circuit & in order to prevent the crane hook from over hoisting and over lowering, one gravity type back up limit switch of hand reset type shall also be provided. This switch will operate in the event of failure of main limit switch. Lever operated limit switches shall be provided at both ends of longitudinal travel and cross traverse. These limit switches shall be self-reset type. The limit switches shall be as per "Data Sheet A"

**3.4.4 Switch**

All switches shall be hand operated; air break, heavy duty, quick make and quick break type. Incoming supply disconnect switch shall be interlocked with panel door so that the same cannot be opened unless the switch is in OFF position. Safety Interlocks-Disconnect Switch-The operating handle of the main/ safety disconnect switch shall be mechanically interlocked with enclosure cover such that the same cannot be opened unless the switch is in OFF position. Main/ safety disconnect switch shall have provision of pad locking in OFF position

**3.4.5. Contactors.**

Contactors shall be suitable for heavy duty, with current rating not less than connected motor full load current. All reversing contactors shall be mechanically and electrically interlocked.

Each contactor shall be provided with three positive acting ambient temp. Compensated thermal overload relay with adjustable setting to suit the motor current. The relay shall be hand reset type, suitable for current. The relays shall be replaceable from front. The main contactor shall be



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electrically interlocked so that it cannot close unless all the motor overload relays are RESET and all controllers are in OFF position. The main contactor shall be also opened by means of emergency push buttons and hoist limit switches.

**3.4.6 Push button and lamp**

Push button shall be spring return type with 2 NO + 2 NC contacts, rated 10A, 240 V AC. Indicating lamps and lens shall be replaceable from front.

**3.4.7 Protective Panel**

**3.4.7.1** The electrical protective panel shall be a cubicle fabricated from Cold rolled sheet steel not less than 2.5mm for front & rear & 2mm for side, top & bottom portion with gland plate of 3mm thick with lockable-hinged door. The control cabinet's door shall be interlocked with the operating handles of isolating switches of supply circuits so as to prevent opening of the door when an isolating switch is closed. A device for bypassing the interlock shall also be provided. It shall be dust and vermin proof with degree of protection as IP-52 or as specified in data sheet A. All the equipment inside the panel shall have permanent identification. The panels shall be front connected type with front-hinged door for access to wiring and terminals. Engraved nameplate shall be furnished for all panels and also for the equipment and devices mounted there on.

The following minimum equipment shall be provided.

- a) One triple pole air break type main contactor with thermal overload relay.
- b) One triple pole main line connecting/disconnecting switch.
- c) Emergency push button at convenient height for the operation for interruption of the entire power.
- d) Thermal overload relay for each drive. It shall be ambient temperature compensated and adjustable type.
- e) Contactors, timer and auxiliary contactors.
- f) Portable Lighting Transformer rated for 415/24V.
- g) Lighting Voltage Transformer with fuse 415/24V.
- h) Control transformer with fuses.
- i) Indicating lamps to indicate the live condition of all three phases.
- j) Main supply ON/OFF lamps on the door of the protective panel.
- k) Electrical interlock shall be provided to prevent the main contactor being closed unless all controllers are in OFF position.
- l) Other equipment as per supplier's standard practice. Air break contactors shall conform to category AC-4 duty. The main contacts shall have the rating for 5 Amps or as specified in the data sheet A. The contactor drop off voltage shall be between 45-50% of rated voltage.



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- m) All internal wiring shall be identified with numbering rules at both ends as per the relevant wiring diagram.
- n) Each panel shall have internal illumination with fluorescent lamp. The inside of the panel shall be painted white.
- o) Separate terminal blocks shall be provided for terminating circuits of various voltage classes. At least 20% spare terminals for the wire terminations shall be provided in the cabinet.

#### **3.4.8 Starter Panel**

Separate panels shall be provided for CT, LT & hoist motion (Main and Auxiliary), with following type of items.

- a. Contactors : AC4 duty for reversing applications  
AC3 duty for non-reversing applications
- b. Switches : AC23 for motor application.  
AC22 for other application
- c. Fuses : HRC
- d. Overload relays: Temperature compensated bi-metallic with single phasing preventer.

#### **3.4.9 MOTOR CONTROL PANEL**

The motor control panels shall be dust and weatherproof to IP-54/55 or as specified in "Data Sheet A" & shall be provided separate for each motion. The panel shall contain minimum the following components.

- a. Switch fuse unit with contacts of adequate rating for each motion.
- b. Thermal overload relay for each drive. These shall be ambient temperature compensated adjustable type.
- c. Contactors, timers and auxiliary contactors.
- d. The panel shall be provided with space heater. The space heater with thermostat shall be located at the bottom of the panel and shall have individual ON/OFF switch.
- e. Terminal blocks shall be stud or snap on type. A protective cover shall be fixed on top of terminal blocks to prevent accidental contact. A minimum of 20% spare terminals shall be provided.
- f. Air break contactors shall be provided for main supply as well as for motors. They shall confirm to category AC-4 as per IS-1322. These shall have three main contacts and 2 No. & 2 NC auxiliary contacts.



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- g. The main contacts shall have the ratings as per duty requirement but auxiliary contact shall be rated for 5 amp 240V AC. The contactor drop off voltage shall be between 45-50% of rated voltage. The contactor coil shall be suitable for 240V AC supply.
- h. The auxiliary contactors shall have 4 No. + 4 NC contacts for control and interlocking purposes. The contacts shall be convertible. The contacts rating shall be suitable for 5 amps at 240 Volts AC.
- i. Adequate protection for overload and short circuit shall be provided for all the three phases of each motor.
- j. Double pole switch fuse unit for control circuit of the contractor 'START (push button and a pilot lamp with the red lens for indicating the contactor "CLOSED" shall be furnished.

#### **3.4.11 Illumination**

Crane lighting and space heating system shall be designed for 240V, 1Phase 50Hz supply and receptacle system with 24V 1Phase 50Hz supply or as specified in the Data sheet A. Suitable dry type transformers shall be furnished for this purpose, complete with isolation facility and Primary/secondary fuses.

- a. Branch Circuits for lighting and receptacles shall be individually protected by switch fuse units.
- b. CFL fixtures shall be used for lighting operator's cabin and bridge platform.
- c. 60W bulkhead fittings with fluorescent lamp shall be used for lighting bridge platform.
- d. Four (4) no.s - 250 W HPSV lamps shall be provided under the bridge as specified in the data sheet "A"
- e. All lighting fixtures shall be mounted with anti-vibration mounting and shall be easily accessible for maintenance.
- f. 24V - 5A - 3 pin industrial socket outlets shall be provided. Minimum four (4) on the bridge along the walk way on both sides of full length platforms.
- g. One (1) portable 40 W hand lamp with min. half span length flexible cable for inspection of crane components.

#### **3.4.13 Grounding**

**3.4.13.1** The crane structure, motor frame and all other electrical equipment/s shall be grounded in accordance with the Indian Electricity Rules. The connections from Crane Bridge to 4th conductor of down shop leads shall be by means of current collector.

**3.4.13.2** The equipment fed by flexible cables shall be grounded by means of fourth core provided in the flexible trailing cable. Pendant push button station shall be earthed



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Separately.

3.4.13.3 The crane structures, motor frames & metal of all electrical equipment on EOT crane shall be effectively grounded as per Indian Electricity Rules. Grounding of the crane to the nearest pit shall be in manufacturer's scope.

3.4.14 Red warning light 3 Nos. shall be provided at both ends of the gantry girder to indicate the aliveness of DSL.

**3.4.15 Wiring Systems**

- a. All electrical equipment, accessories and wiring shall have tropical protection involving special treatment of insulation and metal against fungus, insects and corrosion. All cabling shall be carried out using XLPE insulated fire resistant (FRLS) cables & wiring by Heat resistance PVC wires with stranded conductor
- b. All wiring shall be done with 1100V grade fire resistance PVC insulated wire in conduits or by 1100V grade PVCA PVC cables with extruded inner sheath.
- c. For selecting the cable rating, cable for power wiring, consideration shall be given to the motor duty, ambient temperature grouping and disposition of the cables voltage drop etc.
- d. Armoured cables or un-armoured running through the flexible conduits may be used for power wiring / control and auxiliary circuit wiring shall run through flexible conduits.
- e. Each motor shall be wired independently. Power and control wiring shall be effectively separated.
- f. Each wire shall be identified at both ends with wire designation in accordance with circuit wiring diagram.
- g. All wire termination to the panels shall be provided with clamp type connections screw. Screw Type terminals with screw directly impinging on conductors are not acceptable.
- h. Multi way terminal blocks complete with screw nut, washer and marking strips shall be furnished for terminating the panel wiring.
- i. Not more than two wires shall be connected to any terminal on either side of terminal block. If necessary number of terminals shall be jumped together to provide the wiring points
- j. Each terminal block shall be marked with designation in accordance with conductors wiring diagram.

|                                                                                   |                                                                                        |                                      |  |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------|--|
|  | TITLE<br><br><b><u>TECHNICAL SPECIFICATION</u></b><br><br><b><u>FOR VVVF DRIVE</u></b> | SPECIFICATION NO. PE-TS-435-501-A401 |  |
|                                                                                   |                                                                                        |                                      |  |
|                                                                                   |                                                                                        | SECTION - II B                       |  |
|                                                                                   |                                                                                        | Rev 00                               |  |
|                                                                                   |                                                                                        | 1 OF 5                               |  |

1.0

General

a)

This part of the specification describes the general requirements for the Variable Voltage Variable frequency Drives, herein referred to as AC Drives, for use with standard IEC design AC squirrel cage induction motors. The nominal values, the standard documents and the drive’s minimum performance are defined in this part. **To avoid any mismatch between the motor and its control equipment, the AC Drive shall be capable of auto adjustment by automatic measurement of the motor parameters with/without motor rotation.**

b)

Inverter construction and related devices:

Construction shall be divided in 3 broad sections. Section one converts AC Supply into DC supply. Section 2 Converts and controls DC supply into AC Supply with regulation. Section 3 shall be used for braking action of the motor and Dynamic Braking Unit (DBU) can be inbuilt or external depending upon the drive capacity. VVVF can be used in open loop (without external speed feed back) like in Travel motions or close loop (With external speed feed back) like in Hoist motions. Chokes on input supply side are generally used in crane application for power regulation. Like all other electronic / electric devices VVVF drives are also protected by MCB / MCCB / Fuses. VVVF drives are sensitive to temperature and hence drive internal as well as external cooling fans are provided.

c)

Programming of VVVF Drives.

VVVF drives shall be programmable and for that purpose detachable digital Operator display unit shall be supplied along with the VVVF having required buttons for setting the user constant, functions etc. The VVVF drive is to be fine tuned by matching the motor parameters and setting the parameters on full load.

d)

VVVF drives shall be connected with power supply and these drives generate their own low voltage control supply. Potential free contacts shall be connected to this control supply and few programmable control terminals. Starting / stopping / set speeds operations of VVVF drive shall be achieved by above control connection.

e)

VVVF shall give smooth control over acceleration and deceleration making the motion jerk free and using Variable voltage variable frequency limits the inrush current to the squirrel cage motors. VVVF provides controlled torque to the motor due to which crane operations are jerk free.

1.1

Experience

The Frequency Converter Manufacturer shall have adequate experience in frequency converter manufacturing and have adequate business volume in order to provide credibility in his commitments and a capability of long term support.

1.2

Local support

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The Supplier shall have a permanent representative office with a trained and skilled support staff, in the country where the goods are delivered, in order to prove his commitment for local support and to provide a channel for communication.

The engineers employed by the Supplier's regional office shall be certified by the Manufacturer and provide start-up service including physical inspection of the drive, connected wiring and final adjustments, to ensure that the AC Drive meets the required performance.

The Supplier shall be able to give basic drives training to the Customer's engineers, preferably on the site. The training shall, as a minimum, include system concepts and basic troubleshooting.

## **2.0 Basic requirements for the AC Drives**

### **2.1 General requirements**

The AC Drive shall comply with National(country of origin) and International standards and the recommendations for electrical industrial control devices (IEC, EN, UL, NFC, VDE).

The AC Drive shall be of the most modern design, yet user friendly and be simple to install, commission and maintain. The AC Drive shall be able to start and control the speed of a standard squirrel cage induction AC motor. The AC Drives shall be : CE marked, conforming to European Low Voltage (73/23/CEE and 93/68/CEE) and EMC (89/336/CEE) Directives, UL/CSA marked according to UL 508C.

The AC Drives have to be built to comply with the IEC standards.

The AC Drive shall be a digitally controlled drive, using, at least, the Pulse Width Modulation (PWM) with flux vector control open loop(for travel ) and closed loop(for hoist). It shall have diodes / thyristors in rectifier and IGBT's in the inverter section in their entire power range, and it shall have the following minimum specifications.

|                                       |                                                                      |
|---------------------------------------|----------------------------------------------------------------------|
| Rated Input Voltages                  | 380V -15% 480V +10%, three-phase                                     |
| Rated Input Frequency                 | 50Hz +/- 5%                                                          |
| Output Voltage                        | 0 – Input voltage, three-phase                                       |
| Output Frequency Range                | 0 to 400 Hz                                                          |
| Acceleration / Deceleration Time      | 0.01 – 999s, adjustable, linear, with S, with U or customised shapes |
| Overload capability (Constant Torque) | 150% of nominal current for 1min.                                    |
| Operating ambient Temperature         | -10°C up to 50°C(shall be derated suitably)                          |



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|                             |                                                                                                                                                                                                         |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             | if not rated at 50°C)                                                                                                                                                                                   |
|                             |                                                                                                                                                                                                         |
| Storage ambient Temperature | -25°C up to 70 °C                                                                                                                                                                                       |
|                             |                                                                                                                                                                                                         |
| Maximum operating altitude  | 1000 m without de-rating, 1000...3000 (shall be de-rated suitably)                                                                                                                                      |
|                             |                                                                                                                                                                                                         |
| Max. Relative Humidity      | 95 %, without condensation and dripping water.                                                                                                                                                          |
|                             |                                                                                                                                                                                                         |
| Main Protections            | Over current, short circuit between phase, short circuit between phase and ground, input phase loss, output phase loss, motor overload, over speed, over voltage, under voltage, drive over temperature |

The AC Drive shall be able to give a 100 % output current continuously in the above specified conditions. In order to ensure that the drive can provide the required output current in the specified ambient conditions, the Manufacturer shall inform the required derating, if the ambient temperature given in the project-specific specification is higher than rated ambient of the drive or if the installation altitude is more than 1000 m above the sea level. The de-rating factor shall be specified so that neither the lifetime of the AC Drive nor the unit's performance, overload capability included, nor the reliability of the AC Drive shall suffer.

The VVVF drives shall have all necessary protections i.e input phase loss, earth fault, over voltage, output short circuit, load loss , input transient protection, overload etc

Suitable encoder shall be provided for all motions.

### 3.0 User interface

#### 3.1 General

The user interface shall be identical throughout the power range and type to avoid confusion amongst the users and need for training in several different units.

#### 3.2 Inputs and outputs

A. At least, the following standard Inputs and Outputs shall be provided, to be used in interface with the control system:

|                 |   |                                                                                                                                                 |
|-----------------|---|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Analogue Inputs | : | 1 x Programmable differential voltage input $\pm 10V$ ,<br>1 x Programmable current input 0(4) - 20mA<br>1 x Programmable voltage input 0 – 10V |
| Analogue Output | : | 1 x Programmable analogue outputs 0(4) - 20mA or 0 – 10V                                                                                        |
| Logic inputs    | : | 6 x Programmable logic Inputs isolated from the mains                                                                                           |



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Relay Outputs : 2 x Programmable Digital outputs with a changeover dry contact

All the control terminals shall be clearly marked.

B. At least, it shall be possible to assigned the following functions to the I/Os:

| Analogue input                                                                                                                                                                         | Analogue outputs                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Speed reference<br>Summing reference                                                                                                                                                   | Motor current<br>Motor frequency<br>Motor torque<br>Motor power                                                                                                                        |
| Logic input                                                                                                                                                                            | Relay or logic outputs (open collector)                                                                                                                                                |
| Forward<br>Reverse<br>Jog<br>Preset speeds<br>Reference switching<br>Ramp switching<br>Parameter sets selection<br>Fast stop<br>Freewheel stop<br>+ speed<br>- speed<br>External fault | Ready<br>Drive running<br>High speed attained<br>Drive fault<br>Frequency threshold attained<br>Motor thermal state attained<br>Torque or current limitation attained<br>Brake control |

### 3.4 Programming terminal

- A. The AC drive shall have a keypad /display for programming and controlling purposes. An IP54 or IP65 remote mounting shall be possible at a distance of 10m.
- B. Password protection shall be provided to avoid unauthorized tampering with the set parameters.
- C. The programming terminal shall be able to display the commercial reference of the AC drive and of the options, the software version, the serial number
- D. Direct keypad entry shall be provided to observe the following actual parameters. Any one of the following parameters or actual values shall be selected to be always displayed:-
- Input Voltage
  - Input Frequency
  - Output Frequency
  - Output Power
  - Output Current

|                                                                                   |                                                                       |                                      |  |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------|--------------------------------------|--|
|  | TITLE                                                                 | SPECIFICATION NO. PE-TS-435-501-A401 |  |
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vi) Motor Speed

The following parameters shall always be displayed during normal operation:-

i) Drive Status

The following drive control functions at least shall be available from the keypad:-

- i) Run
- ii) Stop
- iii) Local / Remote selection.
- iv) Forward/Reverse (if function enabled)
- v) Accelerate
- vi) Decelerate
- vii) Parameter setting

3.5 Application programming

The AC Drive shall be designed for both simple and the most complicated applications, yet it shall be user friendly. It shall be possible to reset the parameter settings back to the original factory settings through the keypad.

3.6 PC Tools

The AC Drive Supplier shall have a Windows based PC software available for monitoring and controlling the AC Drives, and the software shall be offered as an option. The software shall be supplied with the necessary hardware and a provision for connecting a PC with the AC Drives. It shall be possible to set and modify parameters, control the drive, read actual values and make trend analysis using the software.

**4.0 Software features**

A. Restart

In the event of a fault trip due to over voltage, over current or loss of analogue signal, the AC DRIVE shall be programmable to attempt an automatic restart. For safety reasons, the maximum number of attempts shall be within a selectable time. If the fault does not clear after the attempts, the drive shall lock out.

B. Brake logic control

The AC Drive shall have a built-in function to control a mechanical brake in order to move the load in a smooth and safe way. The brake logic control shall be adapted to the different movements, hoisting, travel, and orientation.

**5.0 Preferred makes:**

As per attached sub-vendor list

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**TECHNICAL SPECIFICATION**  
**FOR**  
**2x660 MW UDANGUDI TPP-STAGE I**  
**DOUBLE GIRDER EOT CRANE UPTO**  
**100T**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)**

**SECTION-II**

**SUB-SECTION-IIA**

**REV. 00**

**DATE: MAR 2020**

## SITE STORAGE AND PRESERVATION

# **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
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
  - a) GENERAL STORAGE REQUIREMENTS
  - b) GENERAL PRESERVATION REQUIREMENTS
  - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

## **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         |
|------------------------------------------------------------------------------------|-------------------------------------|-----------------|--------------------------------------------------|-----------------|
| <b>Raw material /mechanical items like pipes, plates, structure sections etc.)</b> |                                     |                 |                                                  |                 |
| 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                         |                 |
| <b>Fabricated mechanical items (pressure vessels, tanks etc.)</b>                  |                                     |                 |                                                  |                 |
| 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               |                 |
| <b>Mechanical components like valves, fittings, cables glands, spares etc.)</b> |                                      |                 |                                         |                 |
| 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 |
| <b>Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)</b> |                                      |                 |                             |                 |
| 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                  |                    |
| <b>Miscellaneous items like chain pulley blocks, hoists etc.</b>                               |                                                  |                                           |                                   |                    |
| 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                   |                    |
| <b>Chemicals and consumables ( acid, alkali, paints, oils, reagents and special chemicals)</b> |                                                  |                                           |                                   |                    |
| 66.                                                                                            | Hydro Chloric Acid (HCl)                         | Store in canes/ storage tank in dyke area | Date of production/ leakage/fumes | hazardous chemical |
| 67.                                                                                            | Sulphuric acid (H <sub>2</sub> SO <sub>4</sub> ) | 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 |
| <b>Electrical and C &amp; I items (motors, cables etc.)</b> |                                      |                                                                                                           |                   |                               |
| 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            |                               |
| <b>Special items</b>                                        |                                      | 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.

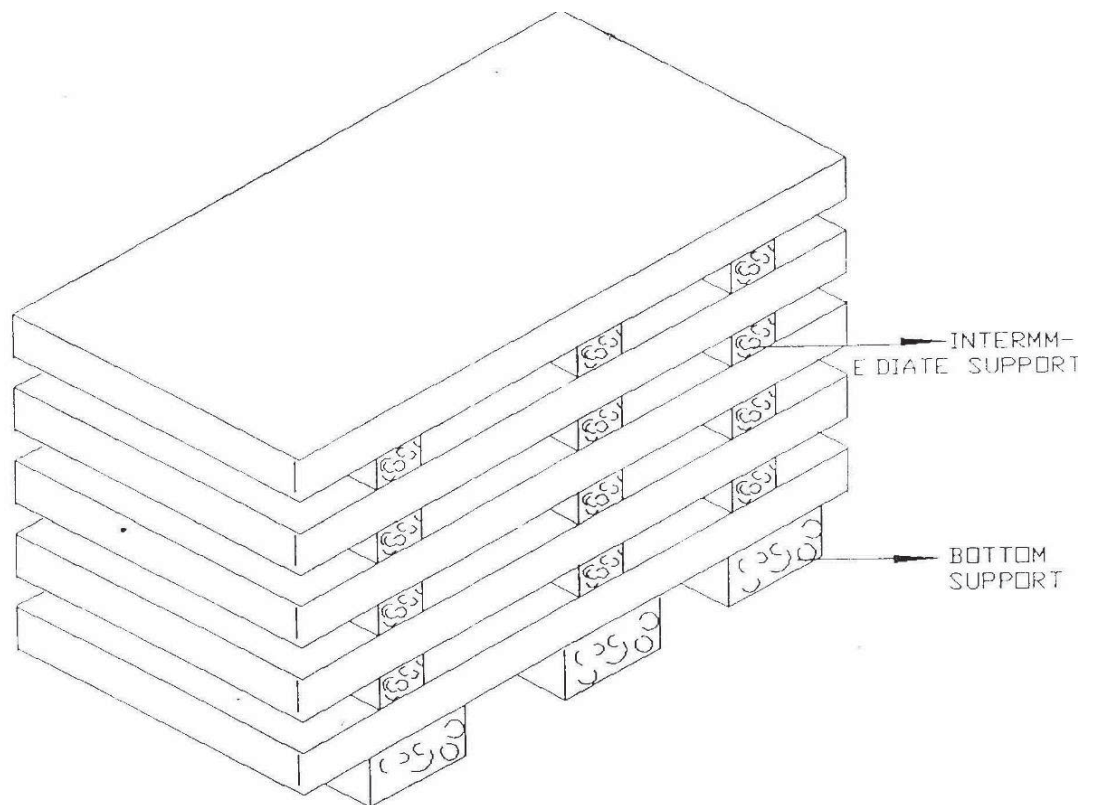


Figure – 1 – PLATE STACKING ARRANGEMENT

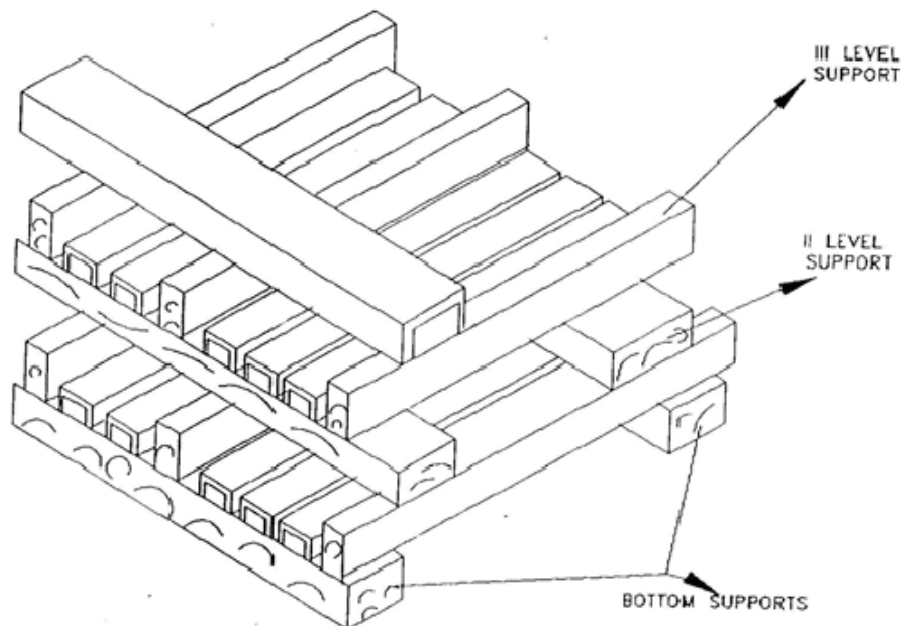


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT



**TECHNICAL SPECIFICATION  
FOR  
2x660 MW UDANGUDI TPP-STAGE-I**

SPECIFICATION No: PE-TS-435-501-A401

PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)

SECTION-I

REV. 00

**Check List for Operation & Maintenance Manual**

|   |                 |   |
|---|-----------------|---|
| 1 | Project name    | : |
| 2 | Project number  | : |
| 3 | Package Name    | : |
| 4 | PO reference    | : |
| 5 | Document number | : |
| 6 | Revision number | : |

| Sl.no. & Sections | Description                                                                                                                                                                                                     | Tick ( √ )if included in Manual |    |                | Remarks |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----|----------------|---------|
|                   |                                                                                                                                                                                                                 | Yes                             | No | Not Applicable |         |
| <b>1.</b>         | <b>Cover page</b>                                                                                                                                                                                               |                                 |    |                |         |
| <b>1.1</b>        | Project Name                                                                                                                                                                                                    |                                 |    |                |         |
| <b>1.2</b>        | Customer/consultant Name                                                                                                                                                                                        |                                 |    |                |         |
| <b>1.3</b>        | Name of Package                                                                                                                                                                                                 |                                 |    |                |         |
| <b>1.4</b>        | Supplier details with phone, FAX ,email address , Emergency Contact number                                                                                                                                      |                                 |    |                |         |
| <b>1.5</b>        | Name and sign of prepared by , checked by & approved by                                                                                                                                                         |                                 |    |                |         |
| <b>1.6</b>        | Revision history with approval Details                                                                                                                                                                          |                                 |    |                |         |
| <b>2.0</b>        | <b>Index</b>                                                                                                                                                                                                    |                                 |    |                |         |
| <b>2.1</b>        | showing the sections & related page nos<br>All the pages should be numbered section wise                                                                                                                        |                                 |    |                |         |
| <b>3.0</b>        | <b>Description of Plant/System</b>                                                                                                                                                                              |                                 |    |                |         |
| <b>3.1</b>        | 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 |                                 |    |                |         |
| <b>3.2</b>        | Equipment list and basic parameter with Tag numbers                                                                                                                                                             |                                 |    |                |         |
| <b>3.3</b>        | Data sheets approved by Customer/for information and catalogues provided by original manufacturer                                                                                                               |                                 |    |                |         |
| <b>3.4</b>        | Associated other packages and Interface /terminal points                                                                                                                                                        |                                 |    |                |         |
| <b>3.5</b>        | P&ID & Process Diagrams                                                                                                                                                                                         |                                 |    |                |         |
| <b>3.6</b>        | GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)                                                                        |                                 |    |                |         |
| <b>3.7</b>        | Single line/wiring diagrams                                                                                                                                                                                     |                                 |    |                |         |
| <b>3.8</b>        | Control philosophy /control write-ups                                                                                                                                                                           |                                 |    |                |         |
| <b>4.0</b>        | <b>Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)</b>                                                                                                |                                 |    |                |         |
| <b>4.1</b>        | Pre-Commissioning Checks                                                                                                                                                                                        |                                 |    |                |         |
| <b>4.2</b>        | handling of items at site                                                                                                                                                                                       |                                 |    |                |         |



**TECHNICAL SPECIFICATION**  
**FOR**  
**2x660 MW UDANGUDI TPP-STAGE-I**

SPECIFICATION No: PE-TS-435-501-A401

PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)

SECTION-I

REV. 00

|      |                                                                                                                                                                                                                                 |  |  |  |  |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|
| 4.3  | Storage at site                                                                                                                                                                                                                 |  |  |  |  |
| 4.4  | Unpacking & Installation procedure                                                                                                                                                                                              |  |  |  |  |
| 5.0  | <b>Operation Guidelines for plant personal/user/operator</b>                                                                                                                                                                    |  |  |  |  |
| 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  | <b>Maintenance guidelines for plant personal</b>                                                                                                                                                                                |  |  |  |  |
| 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,                                                                                                                                                |  |  |  |  |



**TECHNICAL SPECIFICATION**  
**FOR**  
**2x660 MW UDANGUDI TPP-STAGE-I**

**SPECIFICATION No: PE-TS-435-501-A401**

**PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)**

**SECTION-I**

**REV. 00**

|             |                                                                                                                                                     |  |  |  |  |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|
|             | normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.             |  |  |  |  |
| <b>6.6</b>  | List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given |  |  |  |  |
| <b>6.7</b>  | List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.                  |  |  |  |  |
| <b>6.8</b>  | List of mandatory and recommended spare parts list                                                                                                  |  |  |  |  |
| <b>6.9</b>  | Tentative Lead time required for ordering of spares from the equipment supplier                                                                     |  |  |  |  |
| <b>6.10</b> | Guarantee and warranty clauses                                                                                                                      |  |  |  |  |
| <b>7.0</b>  | <b>Statutory and other specific requirements considerations.</b>                                                                                    |  |  |  |  |
| <b>8.0</b>  | <b>List of reference documents</b>                                                                                                                  |  |  |  |  |
| <b>9.0</b>  | <b>Binding as per requirement</b>                                                                                                                   |  |  |  |  |

Checked by  
Dealing Engineer

Key Resource Person

Section Head



TITLE:  
**TECHNICAL SPECIFICATION**  
**FOR**  
**2X660 MW UDANGUDI STPS**  
**DOUBLE GIRDER EOT CRANE UPTO 100T**

SPEC. NO.: PE-TS-435-501-A401  
SECTION: III  
REV. NO. **0** DATE MAR 2020  
SHEET

## SECTION III



TITLE:  
**2X660 MW UDANGUDI STPS**  
**DOUBLE GIRDER EOT CRANE UPTO 100T**

SPEC. NO.: PE-TS-435-501-A401  
SECTION: III  
REV. NO. **0** DATE MAR 2020  
SHEET **1** OF **1**

**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 format attached in the tender

Or

No deviation certificate

- c. Un priced copy of price format indicating quoted/ not applicable against each row/column

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.



**TITLE:**  
**2x660 MW UDANGUDI TPP-STAGE I**  
**DOUBLE GIRDER EOT CRANE UPTO**  
**100T**

**SPEC. NO.:** PE-TS-435-501-A401  
**SECTION:** III  
**REV. NO.** 0 **DATE** MAR 2020  
**SHEET** 1 **OF** 2

**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', 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 is within the contracted price without any extra implications to BHEL after award of the contract.
- d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.
- 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 within the scope of work as tender specification. 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.



TITLE:

**2x660 MW UDANGUDI TPP-STAGE I  
DOUBLE GIRDER EOT CRANE UPTO  
100T**

SPEC. NO.: PE-TS-435-501-A401

SECTION: III

REV. NO. 0 DATE MAR 2020

SHEET 2 OF 2

- 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.
- m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- n) Document approval by customer under Approval category or information category shall not absolve 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. 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.
- o) 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.



**2X660 MW UDANGUDI STPS**  
**DOUBLE GIRDER EOT CRANE UPTO**  
**100T**

SPECIFICATION NO. PE-TS-435-501-A401

SECTION: III

REV 00

DATE MAR 2020

**PRE-BID CLARIFICATION SCHEDULE**

| S. No. | Section/Clause<br>/Page No. | Statement of the referred<br>clause | Clarification Required |
|--------|-----------------------------|-------------------------------------|------------------------|
|        |                             |                                     |                        |
|        |                             |                                     |                        |
|        |                             |                                     |                        |
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|        |                             |                                     |                        |
|        |                             |                                     |                        |
|        |                             |                                     |                        |

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

|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------------------|-----------------------------------|--------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------|------------------------------|
|                                                                                                                                                                                                                                                                                                                      |                | <div>DEVIATION SHEET (COST OF WITHDRAWAL)</div> <div>PROJECT:-2x660 MW UDANGUDI TPP-STAGE I</div> <div>PACKAGE:- DOUBLE GIRDER EOT CRANES (UPTO 100T)</div> <div>TENDER ENQUIRY REFERENCE:-</div> <div>SPECIFICATION NO PE-TS-435-501-A401</div> <div>SECTION III</div>                                                                                                |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| NAME OF VENDOR:-                                                                                                                                                                                                                                                                                                                                                                                     |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| SL NO                                                                                                                                                                                                                                                                                                                                                                                                | VOULME/SECTION | PAGE NO.                                                                                                                                                                                                                                                                                                                                                               | CLAUSE NO. | TECHNICAL SPECIFICATION / TENDER DOCUMENT | COMPLETE DESCRIPTION OF DEVIATION | COST OF WITHDRAWL OF DEVIATION | REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWL OF DEVIATION IS APPLICABLE | NATURE OF COST OF WITHDRAWL OF DEVIATION (POSITIVE/ NEGATIVE) | REASON FOR QUOTING DEVIATION |
| TECHNICAL DEVIATIONS                                                                                                                                                                                                                                                                                                                                                                                 |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
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|                                                                                                                                                                                                                                                                                                                                                                                                      |                | In case of no deviation, the same is to be mentioned here. Otherwise, clause wise devaiitons along with cost of withdrawal of deviation, if applicable shall be furnished in sealed envelope along with Original price bid. However, the same shall be indicated as 'Quoted' under column 'Cost of Withdrawal of Deviation' along with technical offer/ un-priced bid. |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| COMMERCIAL DEVIATIONS                                                                                                                                                                                                                                                                                                                                                                                |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE                                                                                                                                                                                                                                                                                                                                                    |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| NAME                                                                                                                                                                                                                                                                                                                                                                                                 |                |                                                                                                                                                                                                                                                                                                                                                                        |            | DESIGNATIONS                              |                                   | SIGN & DATE                    |                                                                                   |                                                               |                              |
| NOTES:                                                                                                                                                                                                                                                                                                                                                                                               |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 1. For self manufactured items of bidder, cost of withdrawl of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.                                                                                                                                                                                                                                        |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 2. For directly dispatchable items, cost of withdrawl of deviation will be applicable on the basic price including taxes, duties & freight.                                                                                                                                                                                                                                                          |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.                                                                                                                                                                                                                                                                              |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.                                                                                                                                                                                                                                                                                 |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawl of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.                                                                                                                                                                                 |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 6. Bidder shall furnish price copy of above format along with price bid.                                                                                                                                                                                                                                                                                                                             |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.                                                                                                                                                                                                                                                                       |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.                                                                                                                                                                                                                                                             |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 9. For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawl of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.                                                                                                                                                                                                                                                                           |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 11. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.                                                                                                                                                                                                                                  |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 12. Cost of withdrawl is to be given seperately for each deviation. In no event bidder should club cost of withdrawl of more than one deviation else cost of withdrawl of such deviations which have been clubbed together shall be considered as NIL.                                                                                                                                               |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 13. In case nature of cost of withdrawl (positive/negative) is not specified it shall be assumed as positive.                                                                                                                                                                                                                                                                                        |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |
| 14. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.                                                                                                                                                                                                                                                       |                |                                                                                                                                                                                                                                                                                                                                                                        |            |                                           |                                   |                                |                                                                                   |                                                               |                              |

[illegible]