THDC India Ltd

VISHNUGAD PIPALKOTI HEP
4X111 MW

VOLUME – II B & III

TECHNICAL SPECIFICATION
FOR
DOUBLE GIRDER EOT CRANES (ABOVE 50T UP TO 150T)

SPECIFICATION NO.: PE-TS-413-501-A001 Rev 0

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

VOLUME – IIB

SECTIONS	TITLE	Page No
SECTION-A	INTENT OF SPECIFICATION	4-6
SECTION-B	PROJECT INFORMATION (WITH WIND AND SEISMIC DESIGN CRITERIA)	7-13
SECTION-C	SPECIFIC TECHNICAL REQUIREMENT – MECHANICAL	14
SECTION-C1 - A	SCOPE OF SUPPLY & SERVICES, EXCLUSION AND TERMINAL POINTS ETC.	15-22
SECTION-C1 -B	CUSTOMER TECHNICAL REQUIREMENT -SECTION 22: TECHNICAL SPECIFICATION FOR EOT CRANES -SECTION 1: GENERAL TECHNICAL REQUIREMENT -PAINTING REQUIREMENT	23 24-90 91-144 145-153
SECTION-C1 -C	PERFROMANCE GUARANTEE TEST REQUIREMENT	154-156
SECTION-C1 –D	QUALITY ASSURANCE AND INSPECTION REQUIREMENT	157-183
SECTION-C1 -E	DATA SHEET – A	184-209
SECTION-C2	SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL) -ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR -SECTION 10: TECHNICAL SPECIFICAITON FOR CABLE, CABLE RACKS, SUPPORT, TRAYS & ACCESSORIES - INSPECTION / CHECKS FOR MOTORS AND SYNCHRONOUS MACHINE -QUALITY PLAN FOR MOTORS	210-212 213-214 215-253 254-255 256-266
ANNEXURE TO SECTION – C		
ANNEXURE-I	LIST OF MAKES OF SUB-VENDOR ITEMS	267-273
ANNEXURE-II	MANDATORY SPARE LIST	274-279
ANNEXURE-III	LIST OF MAINTENANCE TOOLS & TACKLES	280
ANNEXURE-IV	PAINTING SPECIFICATION	281-283
ANNEXURE-V	MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	284-287
ANNEXURE-VI	FORMAT FOR OPERATION AND MAINTENANCE MANUAL	288-290
ANNEXURE-VII	SITE STORAGE AND PRESERVATION	291-305
ANNEXURE-VIII	PACKING PROCEDURE	306

ANNEXURE – IX	CRANE CLEARANCE DIAGRAM	307-310
ANNEXURE – X	LIFTING DETAILS	311-313
ANNEXURE – XI	SUPPLY PRICE BREAK UP	314-317
SECTION-D	STANDARD TECHNICAL REQUIREMENT -TECHNICAL SPECIFICATION FOR VVF DRIVE -GENERAL TECHNICAL REQUIREMENT FOR LV MOTORS	318-337 338-342 343-347

VOLUME-III

SECTIONS	TITLE	Page No
1	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	349
2	COMPLIANCE CUM CONFIRMATION CERTIFICATE	350-351
3	PRE BID CLARIFICATION SCHEDULE	352
4	ELECTRICAL LOAD DATA	353
5	DEVIATION SHEET FORAMT (WITH COST OF WITHDRAWL)	354

VOLUME - IIB

SECTION – A

INTENT OF SPECIFICATION

SCOPE OF ENQUIRY/INTENT OF SPECIFICATION

1.1 This specification includes, but not limited to design, engineering, material selection, manufacturing and assembly, inspection, testing at manufacturer's works, lubricants & consumables, packing, forwarding and transportation to site, unloading, storage & handling at site, preservation, security / safety at site, erection, commissioning and final load test at site and handing over to BHEL's customer of **Two (2) no. 150 /50/10 T capacity double girder EOT Crane for Power House area, One (1) no. 150/50T capacity double girder crane for Butterfly valve chamber & 1 no. 12T capacity single girder EOT crane for GIS Hall area** and necessary accessories including supply of mandatory spares, operation and maintenance of cranes for 24 months (for Two (2) nos. Power House EOT cranes only).

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 Vol-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 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.

1.10 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 Bidder is advised to visit the site and get familiar with actual site conditions w.r.t. approachability, transportation etc. before submitting the bid.

Note:

Bidder to note that BHEL reserves the right for drawing/document submission through web based Document Management System. Bidder would be provided access to the DMS for drawing/document approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.

- Internet explorer version – Minimum Internet Explorer 7.
- Internet speed – 2 mbps (Minimum preferred).
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked.
- Vendor's internal proxy setting should not block DMS application's link *(http://dms-server.bhelpem.com/Wrench%20Web%20Access/Login.aspx.)*.

VOLUME - IIB

SECTION – B

PROJECT INFORMATION

3. Site and Other Data

(Data is based on Joshimath observatory)

1. CLIMATIC CONDITIONS :

1.1 TEMPERATURE DATA

i)	Temperature of Air in shade	(Ever recorded)
	(a) Maximum temp	31^0 C
	(b) Minimum temp	(-)2.9 ^{0} C
ii)	Maximum variation between day & night temperature during	
	(a) Winter	9.9 ^{0} C
	(b) Summer	11.6^0 C
iii)	Maximum river water temperature (During June)	27^0 C

1.2 RELATIVE HUMIDITY

	Maximum	90%

1.3 RAINFALL DATA

i)	No. of months of tropical monsoon conditions	04
ii)	Average annual rainfall (at Joshimath)	1160 mm
iii)	Average Nos. of rainy days in a year	120
iv)	Occurrence of fog conditions	Nil

1.4 ALTITUDE

i)	Dam site(River Bed)	El 1225 m
ii)	Power House (Service bay level)	El 1041 m
iii)	Switchyard (Potyard over ground)	El 1130 m

2. SEISMICITY

The Project Area lies in the Himalayas which are known as a highly seismic belt.
Seismic data obtained from the Indian Meteorological Department to cover the area between latitude $28^0 – 32^0$ N and longitude $76.5^0 – 80.5^0$ E covers 1169 shocks recorded between the year 1720 to 2005 of magnitude 1.1 to 6.8 at Richter's Scale.
The Seismic Coefficient for the design of the equipment will be considered as specified in Bid Documents.

3. LOCATION AND ACCESS

The site is well connected with all weather roads and is connected to Ghaziabad-Haridwar-Rishikesh-Srinagar-Pipalkoti-Joshimath National Highway No. 58. The project site is about 225 km from Rishikesh.

4. HYDROLOGY

The river Alaknanda drains a catchment area of about 4672 Sq. km. at the proposed dam site. The water availability for the project i.e. the dependable flows for 90 % & 50% dependable year have been assessed as 3737Mcum and 5673 Mcum. The computed inflow series worked out has been adopted as 6700 m^3 /sec as SPF for design of spilling arrangement and the system has been checked for safe passage of PMF i.e. 10800 m^3 /sec.

5. POWER POTENTIAL STUDIES

The 33 years data of water flows on 10 daily basis has been analyzed. For determining 90 % & 50% dependable energy year, the power potential & energy generation for all the 33 years have been computed. An installation of 444 MW comprising generating units each of size 111MW have been proposed. The energy in 90 % dependable year has been summarized below.

Annual Energy Generation

Annual energy generation (GWh)	1812.90
Annual load factor (%)	46.61

Generation during lean flow season

Lean Period Avg. Power (MWc)	74.69
Load factor (%)	16.82

The design energy for tariff at 95% availability in 90 % dependable year has been worked out as 1797.12 GWh.
A pondage of 2.473 Mcum has been provided at diversion dam site, which would enable the station to operate **3.15hrs. per day.**

6. POWER EVACUATION ASPECTS

The 444 mw power generated at 13.8 kv at vishnugad pipalkoti hydro electric project, will be stepped upto 400 kv by unit step transformers. The power will be taken to pooling station near kuwari pass.

7. ENVIRONMENTAL ASPECTS

The proposed project entails submergence of 24.5 ha of area. Mainly forest and partly private land are coming under reservoir submergence. The key impacts are given as below:

- Impacts due to acquisition of forestland.
- Impacts on wildlife, especially species categorized as Schedule-I species as per Wildlife Protection Act (1972)
- Increased potential for fisheries in the reservoir as a result of construction of dam.
- Proper stabilization of quarry sites
- Management of pollution from various sources for labour camps
- Resettlement and Rehabilitation plan for families losing private land and homesteads in project affected villages.

As a part of IEE various management measures including pollution control measures during construction phase, minimal acquisition of forest area, compensatory afforestation, resettlement & rehabilitation plans, area development activities, installation of cyclones /in crushers, etc.

The proposed project is recommended for environmental clearance, which will require approval from Ministry of Environment and Forests, Government of India.

---

4. Salient Features

I. LOCATION:

State	Uttarakhand	
Distt.	Chamoli	
River	Alaknanda	
Dam site	Near Village Helong	(E – 79^0 29'30")
		(N - 30^0 30'50")
P H site (underground)	Near Village Hat	(E – 79^0 24'56")
		(N - 30^0 25'31")

Approach:-

The Vishnugad Pipalkoti Hydro Electric Project (4 x 111 MW) is located on Alaknanda River, a major tributary of river Ganga, in district Chamoli in the state of Uttarakhand. The nearest railhead is Rishikesh (225 Km) and the nearest Airport is Jolly Grant, Dehradun (240 Km). The project is approachable by an all weather road (National Highway No. 58).

X. UPSTREAM SURGESHAFT:

Type	Restricted Orifice type
Diameter	22/15 m Φ (22m Φ from EL.1185m to EL. 1240m) (15m Φ from EL.1240m to EL. 1305m)
Height (from HRT invert)	130 m
Top EL	1305 m
Orifice level	1185 m
Orifice diameter	1.5m
Tunnel invert	EL 1175 m
Maximum surge level	1304 m
Minimum surge level	1196.30 m
Pressure shaft gates	2 nos., 4.2 m x 5.2 m

XI. BUTTERFLY VALVE CHAMBER:

Size	50 m (L) x 9.8 m (W) x 19 m (H)
Butterfly Valve	2 nos., 5.2 m dia

XII. PRESSURE SHAFT:

Nos.	2 / 4
Type	Circular
Diameter	5.2 m / 3.65 m
Length of each PS	351 m / 36.7 m
Design velocity	5.39 m/sec

XIII. POWER HOUSE:

Type	Underground
Size of P/H cavern	127 m x 20.3 m x 50 m
Size of Transformer cavern	112 m x 16 m x 24.5 m
Nos. of units	4
Rated unit capacity	111 MW
Installed capacity	4 x 111 MW = 444 MW
Gross Head	237.0 m
Rated Head	212.46 m
Centre line of unit	EL 1022.0 m
Service bay level	EL 1038 m
Main Inlet Valve (Spherical valve)	3.0m dia, Design Pressure 28.2 Kg/cm^2
Maximum flow through each unit	57.22 m^3/sec
Generator:	
Synchronous speed of Generator	250 rpm
Power factor, Generator voltage	0.9, 13.8kV
Excitation system	Quick response static
Transformers- Type, Nos, No. of Phases,	OFWF, 4, 3, single phase, 46MVA, 13.8/ 420/√3kV.
Step-up voltage, Capacity	400kV

Energy generation (on 90% dependability basis)	1813.03 GWh

VOLUME - IIB

SECTION – C

SPECIFIC TECHICAL REQUIREMENT

VOLUME - IIB

SECTION – C1- A

SPECIFIC TECHNICAL REQUIREMENTS

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 the EOT CRANES 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 cranes 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. Cranes (Two numbers 150 T/50T Double Girder Crane for Power House area, one number 10T electric Hoist with each Power House Double girder crane, One number 150T/50T Double Girder Crane for Butterfly valve house and one number 12 T Single Girder Crane for GIS Hall area) 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, pendent (as per Datasheet A) and panels etc.
f. PVC insulated shrouded bus bar Cu conductor type DSL
g. Earthing arrangement
h. Fill of lubricant till commissioning of cranes
i. Painting of cranes and accessories
j. Permanent cables for all four cranes as per datasheet A
k. Temporary cables for operation of each crane during erection stage of the plant (Half the bay length + 25m) – For Power House Crane and Butterfly valve house crane only.
l. Rail including all accessories and end stopper
m. Maintenance tools & Tackle
n. Erection & Commissioning spares
o. Mandatory Spares

p. Operator's cabin (for Power House Crane & Butterfly valve house crane ONLY)

q. Main Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the crane.

r. Pair of wire rope slings as given below:-

i. Four (4) pairs of wire rope slings for different loads (i.e. 15T, 65 T and 150 T) upto respective rated capacity for Power House crane.

ii. Two (2) pairs of wire rope slings for different loads (i.e. 65 T and 150 T) upto respective rated capacity for Butterfly valve House crane.

iii. Two (2) pairs of wire rope slings for 15T load for GIS Hall crane.

s. A storage rack each for safe keeping of the slings separately for EOT cranes of each area (viz. power house, butterfly valve house & GIS hall)

t. Slings and cradle for load & overload testing of the cranes on returnable basis.

u. Additional isolating switch for maintenance of Crane at bay end with switch at gantry girder.

v. Sole Plate (for rail fixing) and anchor bolts.

w. One number Electric hoist (10T capacity) along with required accessories to be erected on monorail beam welded underneath one bridge girder of each Power House crane (Total 2 nos. Electric Hoist).

1.1.4 Maintenance Tools and Tackles

As per Annexure III, section-C , Vol. IIB of this specification

1.1.5 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 it use. The items supplied shall be of the best quality. The minimum requirement of mandatory spare parts is listed in Annexure –II section-C, Vol. II-B of this specification.

1.1.6 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. Oil and grease required for first filling alongwith ten (10%) percent excess quantity. 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.

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

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

1.2.2. **Arranging test load at site**

The Test Load for the load test at Site shall be provided by BHEL within the vicinity of project site (including barrage area). Transportation, handling etc. of test loads from their location to the power house & Butterfly valve house and back to their original location shall be done by the contractor. Test load in the form of rolled steel, plates, girder, concrete blocks etc., as available at the site shall be made available by the purchaser. 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.

1.2.3. Transportation of crane from storage area to site (Power house/GIS Hall)

1.2.4. Erection and Commissioning

1.2.4 Demonstration / Load test

1.2.5. Operation & maintenance (FOR POWER HOUSE CRANE ONLY) for two years with details as per Annexure – A of Section C1 (Operation & maintenance for 2 years which may be further extended as per requirement to be intimated by BHEL site. However bidder to note that warranty period as per relevant clause of GCC shall start after handling over the cranes to BHEL/customer after completion of O&M services.)

1.2.6 Obtaining clearance and acceptance certificate from the concerned competent authority after site test. Necessary fees/expenditure as required shall be borne by the supplier.

1.2.7 Training to customer's O&M staff

1.2.8 Three (3) days supervision for erection of sole plate and anchor bolts (for rail fixing) for Power house area and Butterfly area each.

1.3.0. **PAINTING & COLOUR SCHEME**

As per Annexure IV, section-C , Vol. IIB of this specification

2.0.0. **Works Excluded**

Supply feeder shall be provided by BHEL/customer (as per electrical scope matrix of section C2, Vol IIB).

3.0.0. **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-C, volume II-B of this specification.

4.0.0. **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 volume III 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**.**

5.0.0. Makes of Sub - Vendor items

Makes of bought out items as per Annexure-I, section C, volume II-B 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.

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

Annexure – A

OPERATION AND MAINTENANCE SERVICES SHALL INCLUDE BUT NOT LIMITED TO FOLLOWING (FOR POWER HOUSE CRANE ONLY)

1.0 Scope covers operation and maintenance service including manpower, supervision, consumables etc. for complete operation and maintenance of Two numbers 150 T/50T Double Girder Crane for Power House area(along with 10 T Electric Hoist with each Power house crane) for two years after successful erection, commissioning & load testing. The O & M period shall be started after successful load testing at site. Final handing over of the crane/s to the end client shall be after successful completion of O & M contract.

2.0 For Operation of the Crane An experienced crane operator or shall be available for each crane as and when required by BHEL for at least 16hrs a day, daily.

3.0 For Maintenance of the Crane

a) Break-Down Maintenance

i) In case of any break-down of the crane during the contract period, service engineer shall be made available at site within 72 hrs.

ii) All the critical spares and consumables, as deemed necessary by the manufacturer shall be made available at the site. No delay in crane maintenance shall be allowed by BHEL due to non-availability of required spare at site.

b) Preventive Maintenance

i) Following work should be carried out quarterly

Bridge and Trolley wheel assembly	Checking for wear, flat spots and cracks in flange. Ensure drive wheels are of the same diameter.
Runway	Checking alignment and elevation of gantry track. Checking rail clamp bolts.
Machine Bolts	Checking all foundation bolts of Electrical and Mechanical equipment for tightness.
Structural Bolts	Checking for tightness. They should also be checked after the first month of operation.
Flexible Couplings	Checking pins and teeth for wear, cleaning and greasing.
Cross-shaft Plummer	Dismantling cap. Cleaning and checking oil seals and to be

Blocks	packed with fresh grease.
Trolley Collectors	Checking of cable trolleys / cabling / chain. Ensuring connection of trolley wheels is kept through entire length of span.
Brakes	All Brake assembly will be checked for loose connection, earthing connection, linings for wear, leakages and adjustments to ensure brake is not rubbing the brake drum during operation. Greasing pins and operation adjustment of brakes.
Resistor Connections	Checking, tightening connections at grid joints and at cable terminations.
Control Station	Clean out control cabinets. Checking of all connection at push buttons, master controllers contact tips, cams and terminals.
Control Panels	All Control Panels will be checked for loose connection and cleaning the contactor contacts, if required will be replaced.
Electrical Motors	All motion motors connection will be checked for loose contacts in terminal box loose crimping of wire lugs, loose contacts on slip ring assembly with carbon brush. Earthing connection with motor.
Safety Switches	All limit switches will be checked for desired operation and limits. Emergency switches will be checked.
Main Collectors	Checking of worn collector shoes, sag in main runway wiring, ensuring contact is kept through entire length runway properly.
Electrical connections	Checking throughout electrical equipment for loose connection such as selector switches, junction boxes, min isolator switch etc.
Lubrication	All gear box and thrusters' oil level will be checked. All bearings, couplings' grease will be checked.
Testing	After completion of checking and required rectification, trolley will be checked for idle operation, for brake operation, limit

	switch operation & safety switch operation. All motor currents will be checked on no load.

ii) Following work should be carried out annually

Gear Boxes	Oil seals will be checked, if required will be replaced. Gear and pinion teeth will be checked. Drain the oil cleaning gear box and refill fresh oil.
Motor	All motors' insulation test and meagre test will be carried out.
Resistance Box	All resistance boxes' step resistance value will be checked.

iii) Besides the quarterly and annual preventive maintenance schedule mentioned above, operator shall carry out any daily, weekly, monthly maintenance schedule as deemed necessary and shall operate the crane only when the fitness of the crane for operation has been ensured.

4.0 Bidders' scope of work shall also include, arranging the statutory clearance from the concerned Government body/Authority as and when required for renewal of license during the O & M period. It shall be bidder's responsibility to ensure the presence of competent authority at the time of testing and obtaining the clearance and acceptance certificate from the concerned authority. Necessary fees/expenditure as required shall be borne by the supplier.

VOLUME - IIB

SECTION – C1-B

CUSTOMER TECHNICAL REQUIREMENT

SECTION- 22

TECHNICAL SPECIFICATIONS OF EOT CRANES

22.1 SCOPE OF SUPPLY AND SERVICES

22.1.1 Main Equipments

The supplier shall have to perform the designs, engineering, manufacture, testing at works before despatch, supply, transportation, insurance, despatch & delivery F.O.R. project site of Vishnugad Pipalkoti Hydro Electric Project in Uttaranchal, unloading, storage & preservation at site, complete work of site assembly, erection, testing and commissioning and remedial action, if any, upto defect liability period of the undermentioned EOT cranes and their associated accessories:

a) Two (2) Nos. EOT cranes each of 150 T / 50 T/10T(mono rail) rated capacity i.e. Main Hook of capacity of 150 T, and Auxiliary Hook of capacity of 50 T and a mono rail hoist of 10 T capacity provided on the girder of each crane, both suitable for operation from operators cabin as well as pendant control and suitable to operate in tandem as and when required, complete with associated accessories, such as slings for main hook and auxiliary hook control and operating equipment for above mentioned underground Power House.

b) One (1) No. EOT crane of 150 T / 50 T rated capacity i. e. Main Hook of capacity of 150 T and auxiliary hook of 50 T, complete with pendant control, associated accessories, such as slings, control and operating equipment for underground penstock guard Valve House.

c) One (1) No. EOT crane of 12 T rated capacity, complete with pendent control, associated accessories, such as slings, control and operating equipment for underground GIS Hall.

d) One (1) set each of suitable crane rails complete with foundation and clamping devices for each of the above mentioned EOT cranes listed at a), b) and c) above.

e) One (1) set each of suitable down shop leads / conductors complete with installation fixtures and clamping devices and insulators for each of the EOT cranes listed at a), b) and c) above.

22.1.2 Accessories and Spares

(This is to be read inconjunction with Clause no 1.1.3.m, 1.1.3.o & 1.1.3.r of Section C1-A of Vol. IIB.)

The scope shall also include the following items:

a) One (1) set each of the required accessories, spares, and consumables as specified in the specifications and those which are not explicitly mentioned but are necessary and essential for completion of works for each of the above mentioned EOT cranes.

b) One (1) sets each of all mechanical tools, special tools, instruments and devices required for routine maintenance, checking, disassembly, reassembly etc. for the above four (4) nos. (Three sets) of cranes.

c) Two (2) pairs of wire rope slings for different loads upto respective rated capacity for each of the above four numbers of cranes. A storage rack each for safe keeping of the slings separately for each of the three categories of EOT cranes shall also be supplied. Tags beyond wear and tear indicating the capacity of cranes for all slings being provided for each crane may be fixed on their both ends.

d) Oil and grease required for first filling alongwith ten (10%) percent excess quantities.

e) One (1) number cradle or test load frame and associated slings suitable for rated load and overload tests of the cranes.

22.1.3 Services

The scope shall include the following services:

a) Storage and preservation of EOT cranes at site till site assembly, erection, testing and commissioning of all the cranes are over including touch up painting of cranes at site.

b) All other works incidental to and connected with the above services from delivery up to handing over the equipment after successful commissioning.

c) Perform all tests as described in these specifications in accordance with applicable standards. Any defect noticed

during tests or during the guarantee period or to testing and commissioning shall have to be removed on the spot or replacement of part by the supplier free of cost.

d) Complete work of site assembly, erection, testing and commissioning.

e) A ladder from service bay to operator's cabin.

f) Training of purchaser's engineers as mentioned in Section-1 of General Technical Requirements of the Volume-II of Bidding Document.

22.1.4 Technical Requirements

The detailed technical and other requirement of the crane equipments and services are described in subsequent Section of these technical specifications.

22.1.6 Facilities by Purchaser

The following equipments / facilities at site shall be furnished by the purchaser:

The supplier would be regained to inform in advance about the location and requirements of power supply.

- 415 V, 50Hz, 3 phase, four wire electrical power supply for all crane equipments.

22.2 TECHNICAL REQUIREMENTS OF CRANE EQUIPMENTS

22.2.1 FUNCTION

22.2.2 Power House Crane

The powerhouse cranes will be used principally for the installation and removal of various equipments including all heavy pieces of equipment located in the powerhouse such as generator rotor assemblies, stator sections and assemblies, and turbine runner assemblies, power transformer sub-assemblies. The assembled generator rotor shall be the heaviest assembly to be handled by the crane and this shall be done by joint / tandem operation of the two cranes. Precise handling of valuable machinery at slow speed is required. The auxiliary hoist will be used for higher speed service, lesser weight assemblies and sub-assemblies.

22.2.2.1 Pressure Shaft BF Valve House Crane

The Pressure Shaft Butterfly Valve House Crane will be used for the installation and removal of all pieces of equipments located in the valve house such as valve sub-assembly / assemblies, valve disc, valve body, dismantling joint, oil-pressure equipments, electric panels, and in rare exigencies for opening the closed valve through crane actuated lifting of counter-weights (of valve).

22.2.2.2 GIS Hall Crane

The GIS Hall crane will be used for the installation and removal of sub-assemblies and assemblies of various GIS equipments located in the GIS Hall.

22.2.3 GENERAL DESCRIPTION AND OPERATING DUTIES / CONDITIONS

22.2.3.1 Operating Conditions

The cranes shall be designed for indoor service. After installation of the generating units and auxiliaries, Butterfly Valve and GIS equipments are completed, respective cranes will be used for maintenance purposes.

22.2.3.2 General Arrangement & Specification Drawings

Each crane shall be an electrically-operated single-trolley overhead travelling bridge crane. The general arrangement of these cranes

shall be as shown in the specification drawings. Each crane shall operate on a runway provided with suitable and standard crane rails supported on crane beams as shown in the specification drawings. Access to the crane shall be from inside the caverns as shown in the drawings.

22.2.3.3 Service Classification

The cranes shall be M3 as per IS: 3177 and be rated according to **Class-2 Duty as per IS: 807**.

22.2.3.4 Conforming Standards and Codes

The cranes and their components shall be manufactured and tested in accordance with applicable Indian standards or equivalent specifications. List of some of the relevant major standards is given below. Latest version of these standards shall be applicable.

1. IS - 3177/BS : 466 - Code of Practice for Electric overhead travelling cranes and gantry cranes other than steel work crane.

2. IS - 807/BS : 2573 - Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists.

3. IS - 5749/BS : 3017 - Forged Ramshorn hooks.

4. IS - 2266/BS : 302 - Specifications for steel wire ropes for general engineering purposes.

5. IS - 6938 - Code of Practice for design of rope drum and chain hoists for hydraulic gates.

6. IS - 325/BS : 2960 - Three phase induction motors.

7. IS - 13947 (Part 4/sec 1) - Contactors and motor starters - Electromechanical contactors & motor starter.

8. IS - 2062 - Steel for general structural purposes.

9.	IS - 3815	- Point hooks with shanks for general engineering purpose.
10.	IS - 1030	- Carbon steel castings for general engineering purposes.
11.	IS - 1875	Carbon steel billets, bloom, slabs and bars for forgings.
12.	IS - 210	- Grey Iron castings.
13.	IS - 1363 (Part 1,2,3)	-Hexagon head bolts, screws & nuts of product grade C.
14.	IS - 1364 (Part 1,2,3,4,5)	- Hexagon head bolts, screws & nuts of product grade A & B.
15.	IS - 4460 (Part 1,2,3)	- Gears - spur & helical gears - calculation of load capacity.
16.	IS - 800	- Code of practice for general construction in steel.
17.	IS – 2762	- Wire rope sling and sling legs.
18.	Other equipments	- Applicable ISS or equivalent standards.

22.2.3.5 Operating Parameters and Speeds

I Power House Cranes

It will be a double hooks crane (one Main Hook, one Aux. Hook.

Each EOT crane for Power House shall be suitable for the following **parameters / duties :**

A) Rated Capacity (in Tonnes)

a) Main Hoist
b) Auxiliary Hoist

B) Crane Span (approx.)

Shall be as per attached Annexure IX: Crane clearance diagram

C) Normal speeds & micro speeds (Inching) with full loads.

a. For loads upto 150 T

i) Normal hoisting speed 1.00 m/min

ii) Micro speed adjustable from minimum to Maximum of speed of the hoist

b. For loads upto 50 T

i) Normal hoisting speed 5.00 m/min

ii) Micro speed adjustable from minimum to Maximum of speed of the hoist

c. For loads upto 10 T

i) Normal hoisting speed 5.00 m/min

ii) Micro speed adjustable from minimum to Maximum of speed of the hoist

d. Trolley Travel Speed

i) Normal speed 15.00 m/min

ii) Micro speed adjustable from minimum to maximum speed

e. Bridge Travel (longitudinal travel)

i) Normal speed 20.0 m/min

ii) Micro speed adjustable from minimum to maximum speed

f. Monorail travel

i) Normal speed 15.00 m/min

ii) Micro speed adjustable from minimum to maximum speed

D) Max. acceleration / deceleration of bridge travel & trolley travel 0.2 m/ sec^2

E) Crane Hook Vertical Travel Reaches

a) Between machine hall floor level to upper most position

i) For Main Hoist
ii) For Aux. Hoist
iii) For Monorail Hoist

Shall be as per attached Annexure IX: Crane clearance diagram

b) Between machine hall floor level to lower most position

i) For Main Hoist
ii) For Aux. Hoist
iii) For Monorail Hoist

c) Total Hook Travel
i) For Main Hoist
ii) For Aux. Hoist

iii)For Monorail Hoist

Shall be as per attached Annexure IX: Crane clearance diagram

F) Horizontal Reach of Hook from Rail C/L

a) Crane No. 1
i) Main Hook (150 T)
3100 mm
ii) Auxiliary Hook (50 T)
≤ 1700 mm
iii) Monorail Hook (10 T)
1800 mm

b) Crane No. 2
i) Main Hook (150 T)
ii) Auxiliary Hook (50 T)
3900 mm
iii) Monorail Hook (10 T)
1800 mm

Shall be as per attached Annexure IX: Crane clearance diagram

G) Clearance of hooks from inside of end walls on

a) Service Bay End
b) Power House End

Shall be as per attached Annexure IX: Crane clearance diagram

H) Trolley travel lengths

a) Trolley travel length max. feasible for specified

crane span, shall ensure specified hook reaches.

I) Distance from rail C/L to nearest side obstruction on

Up-stream	≥ 750 mm
Down-stream	≥ 750 mm

J) Distance from the crane bridge end to nearest side obstruction on

Up-stream	≥ 200 mm
Down-stream	≥ 200 mm

K) Means for Micro speed for Inching motion for main & auxiliary and monorail lifting hooks — Stepless speed control

II B.F. Valve House Crane

EOT crane for Butterfly Valve House shall be suitable for the following **parameters / duties.**

A) Capacity (in Tonnes)

a) Main Hook
b) Auxiliary Hook

Shall be as per attached Annexure IX: Crane clearance diagram

B) Crane Span

C) Normal speeds and micro speeds (inching) with full loads.

a) For loads up to 150 T
   i) Normal speed — 1.0 m/min
   ii) Micro speed — adjustable from minimum to Maximum of speed of the Hoist

b) For loads up to 50T
   i) Normal speed — 8.0 m/min

ii) Micro speed — adjustable from minimum to Maximum of speed of the Hoist

c) Trolley Travel
i) Normal speed — 10 m/min
ii) Micro speed — adjustable from minimum to Maximum speed

d) Bridge Travel (long)
) Normal speed — 20 m/min
ii) Micro speed — adjustable from minimum to Maximum speed

D) Max. Acceleration / deceleration 0.2 m/sec^2 bridge travel and trolley travel

E) Crane Main Hook Vertical Travel Reach
a) Between B.F. Valve floor level to upper most position — Shall be as per attached Annexure IX: Crane clearance diagram

F) Position of Hook from Rail C/L

a) Main Hook (150T) — Shall be as per attached Annexure IX: Crane clearance diagram

G) Clearance from inside of end wall on

a) Access Adit End
b) Far (Closed) End — Shall be as per attached Annexure IX: Crane clearance diagram

H) Runway, travel lengths

a) Length of runway
b) Trolley travel length — Max. feasible for specified crane span, shall ensure specified hook reaches.

I) Distance from rail C/L to nearest side obstruction on

Up-stream
Down-stream — Shall be as per attached Annexure IX: Crane clearance diagram

J) Distance from the crane bridge end to nearest side obstruction on

Up-stream	≥ 100 mm
Down-stream	≥ 100 mm

K) Means for Micro speed for Inching — Stepless speed control motion for main & auxiliary lifting hooks

III GIS Hall Crane

It will be a single hook crane.

EOT crane for GIS Hall shall be suitable for the following **parameters / duties**:

A) Capacity (in Tonnes)

B) Crane Span

Shall be as per attached Annexure IX: Crane clearance diagram

C) Normal Hoisting speeds and micro speeds (inching) with full loads.

a) i) Normal speed — 5.0 m/min
ii) Micro speed — adjustable from minimum to Maximum of speed of the hoist

b) Cross Travel
i) Normal speed — 15 m/min
ii) Micro speed — adjustable from minimum to Maximum speed

c) Bridge Travel (long)
i) Normal speed — 30 m/min
ii) Micro speed — adjustable from minimum to Maximum speed

D) Max. acceleration / deceleration of bridge travel and trolley travel — 0.2 m/sec^2

E) Crane Hook Vertical Travel Reach
a) Between GIS Hall floor level to upper most position — ≥ 9000 mm

F) Position of Hook from Rail C/L — Shall be as per attached Annexure IX: Crane clearance diagram

G) Runway, travel lengths

a) Gantry rail level
b) Length of runway
c) Trolley travel length

Shall be as per attached Annexure IX: Crane clearance diagram

H) Distance from rail C/L to nearest side Obstruction on

Up-stream ≥800 mm
Down-stream ≥800 mm

I) Distance from the crane bridge end to nearest side obstruction on

Up-stream
Down-stream

Shall be as per attached Annexure IX: Crane clearance diagram

K) Means for Micro speed for Inching operation for hook — Stepless speed control

22.2.3.6 Tandem Operation

For handling generator-rotor with shaft, generator stator or any other heavy equipment whose weights exceed the power house individual crane capacity, both the P.H. cranes will be used jointly and simultaneously for handling such equipment with the help of a suitable lifting beam which can be attached with both the main hoists of the two cranes. The lifting beam shall have suitable in-built pins for firmly attaching to the main hoists of the two power house cranes.

For joint (tandem) operation, the power house cranes shall be designed to be coupled electrically and mechanically and all operations / controls of both the cranes shall be carried out by a single operator, common for both the cranes, from only one of the two crane control cabins or by a single radio control operator. One of the cranes shall act as a master crane and other as slave crane

and this duty of the cranes shall be interchangeable. Suitable provisions in the design shall be made to enable and ensure that all operations and control of both the cranes shall be perfectly synchronized for all travel and hoisting motions.

The above mechanical and electrical coupling shall be easy and reliable. When operating in tandem the two cranes shall maintain perfect horizontality of the lifting beam in all motions during such operation. The crane hook shall have suitable pins and holes for attaching the lifting beam to the two main hoists. The crane manufacturer shall coordinate with generator manufacturer regarding compatibility of designs of lifting beam and lifting devices of the generator rotor and stator.

22.2.3.7 Simultaneous Operation of Hoists

The Power house cranes will be required to handle the hydro-generating plant and machinery, for lighter equipment independently and for heavy equipment in tandem.
Normally one hoist would be operated at a time. It shall, however, be possible to change the position of components using both the hoists by manipulation of the hoisting and other movements as the case may be.

22.2.3.8 Performance / Quality of Operations

Crane shall be capable of raising, lowering, holding and transporting the rated load without any damage to or excessive deflection of any crane component.

Following tolerances shall be maintained in the operation of the crane

a) Smooth control of vertical movement to within 1 mm for loads to be handled by the main hook of the cranes and 2 mm for loads to be handled by the auxiliary hooks of the crane with hook carrying rated load at a time and hoist, brakes properly adjusted for normal operation.

b) Control of bridge and trolley motion to be within 5 mm.

c) The motor speed not to exceed 105% of the synchronous speed while lowering the rated load.

d) The vertical deflection of the main girders caused by the rated load plus all dead loads shall be as per IS 803.

22.2.3.9 Hook Reaches and Crane Clearances

a) Limits of travel of the hoist of each crane are specified above for compliance by the supplier.

22.2.3.10 Micro Speed (Inching Motion) & Acceleration

a) Normal speeds for hoisting, cross travel and long travel shall be as indicated as above.

b) Cranes shall also have provision for raising and lowering of the loads at reduced speed (inching) of $1/10^{th}$ (one tenth) of the normal speeds in both main and auxiliary hoist capacities.

22.2.3.11 Arrangement of Operators Cabins

a) In respect of the operator cages / cabins of the two cranes for the Power House, it shall be fitted on the downstream side on the non adjacent girders. This arrangement is necessary as it will ensure that while operating the cranes in tandem, the lifting beam shall not interfere with cages even when it is moved to extreme upstream sides. The mono-rail hoists shall also be installed on the non-adjacent girders.

b) Of the two cranes of power house, the crane installed on the left (when viewing from downstream) shall be designated as crane No. 2. The crane on the right side (i.e. service bay side) shall be designated as crane No. 1.

22.2.4 STRUCTURAL FEATURES AND PARTS OF CRANES

22.2.4.1 General

The cranes shall conform to all the requirements of clause 22.3.4 on "Structural Design criteria" of section- 22.3.

22.2.4.2 Crane Bridge

a) The crane bridge, made of two (2) girders as box type construction, reinforced with stiffening ribs, supported on end trucks, shall be designed to safely carry the full rated load without undue vertical or lateral deflection or vibration. The design shall ensure that girder vibrations are quickly dampened to within 1 mm in 4 seconds. However, in case of GIS Hall Crane, the crane bridge shall be a single bridge construction.

b) The bridge shall be designed taking into consideration the specified transport and handling limits in regard to size and weight of packages. Accordingly the bridge shall be sectionalised into suitable but minimum number of sections within the transport constraints and also of need of field erection & handling.

c) The joints between the sections shall be spliced and shall be made by most appropriate method. Most appropriate design shall be adopted for the spliced joints between the sections.

d) The bridge shall have the following provisions :

i. Welded end-stop of steel to act as stoppers for trolley / crane.

ii. Heavy rails for trolley consisting of preferably 125 mm square bar of manganese alloyed steel, continuously welded to one corner at each main girder.

iii. Large gusset and skew plates with interference fit bolts at girder ends to connect to the end trucks to maintain a square rigid structure secure against shock & skewing of crane on the track.

iv. Suitable number of guide rollers for guiding trolley wheels on rail track.

e) Wheel stoppers shall be provided alongwith buffer stoppers for long as well as cross travel.

22.2.4.3 Trucks (End carriages)

a) The trucks of box type construction with openings at each end for receiving the truck wheels shall be either cast or weld fabricated or bolted or riveted structure of steel and shall have adequate strength and stiffness.

b) The ends of the trucks shall be shaped to form a hood over the truck wheels extending beyond them to receive the track (rail) sweeps and bumpers. The trucks shall be arranged so that wear may be compensated in order to maintain the drive gear in proper mesh. The size of the journals shall be ample to carry the rated capacity load at specified speed without excessive heating during continuous operation.

e) Wheel assembly shall be mounted on L-type bracket and shall be so arranged that replacement of any wheel can be achieved from the side without undue difficulties. The wheel base shall not be less that $1/5^{th}$ (one fifth) of span, as reckoned between the centres of outer wheels. The end trucks shall be designed to contact end stops.

f) Each truck shall have :

i. Suitable even numbers of double flanged rail wheels with bearings running on suitable axles, wheels, fracture props, buffer etc. for easy maintenance.

ii. Suitable track sweeps at each end of trucks, effective in both directions of travel.

iii. Guide rollers extending below the top of rail on both sides to prevent the trucks from leaving the rails.

iv. Lugs to prevent a drop of not more than 25 mm in case of axle getting broken.

v. Resilient bumpers or spring buffers on contact faces of end stops.

vi. End stops at each end of runway rails, designed in such a way that they make contact with the face of the end truck and not the wheel.

vii. Suitable pads on each truck for jacking the crane for changing truck wheels and bearings, to be so designed and provided as not to interfere with the replacement of the truck wheels and bearings.

viii. Lifting jib arrangement alongwith a lifting jack. Jack need not be of built-in type.

ix. Hand holes with removable covers, in each closed compartment of end trucks to facilitate painting of the interior with a spray gun without major disassembly.

e) Arrangement for jacking the cross traverse wheels shall be similar to the one described above for L.T. wheels. The supplier shall furnish the technical details of jacks to be supplied.

22.2.4.4 Wheels, Axles and Wheel Bearings

A) **Wheels**

a) The bridge shall be carried on at least 8 (eight) wheels, 4 (four) on each side, for power house cranes and 8 (eight) wheels, 4 (four) on each side for B.F. Valve house crane and adequate numbers of wheels for GIS Hall crane, suitably mounted on trucks and designed so as to distribute the load equally on truck beams & wheels. The wheels shall meet the following requirements :

i) Double flanged type with treads machined and ground to size.

ii) Turned, bored and ground to true and uniform diameters concentrically.

iii) Made of cast steel or forged steel and heat treated. Cast iron wheels are not acceptable.

iv) Equalized in pairs or individually as necessary.

v) Flanges tapered and radiused to prevent derailment.

vi) Tread width to have proper clearance, and to be of sufficient size to withstand maximum static and moving / rolling loads. The BHN of hardness of wheels shall be atleast 50 points more than the BHN of rails.

vii) Bridge wheels shall be identified for interchangeability. Similarly trolley wheels shall be identified for interchangeability.

b) The design of the wheel truck assembly shall be such that it would allow the wheels to adjust themselves to irregularities of the runaway within allowable limits

B) Wheel Axles

The wheel axles shall be in accordance with following:

a) Made of forged carbon or alloy steel.

b) Accurately turned , ground and polished at the positions fitting into wheels.

c) Suitable interference fit with the wheels.

d) Driving wheel axles to be keyed, in addition to interference fit.

C) Wheel Axle Bearings

The wheel bearings shall be interchangeable, easily removable type & shall comprise the following :

a) Bearing housings / journals fitted into truck bodies.

b) Anti friction roller bearings with high pressure grease lubrication.

22.2.4.5 Trolley

The trolley shall be made as a welded frame of structural steel and shall be designed and fabricated in accordance with the following ;

a) Provision of adequate bracing to withstand vertical, lateral and torsional strains.

b) Properly machined to receive the drum, wheels, axles and motors for hoisting and cross travel.

c) Provision of heavy duty roller bearings, for trolley wheels & winding drum, with bearing caps and fittings for pressure lubrication.

d) Double end resilient or spring buffers at bottom of trolley frame on each side to engage stops at each end of the bridge.

e) A provision to fit / receive a device to lift the heaviest parts of the trolley viz. the drum and motors for maintenance without any external place for anchoring the hooks or need for any other device.

22.2.4.6 Operator Cabin, Walkways and Ladders, Safety Guards

a) Operator Cabins for power house crane

The cabin of structural steel frame shall be designed and constructed in accordance with the following requirements

i. Enclosed type for indoor service having adequate working space for operation and maintenance with sufficient ventilating type windows which also allow the operator to have clear view of all operations.

ii. Adequately braced to the crane so as not to sway, swing, or shake.

iii. Floor of steel plates securely connected to the frame and covered with matting.

iv. Railing on all open sides, a ladder for access to the crane bridge walkway, a CO_2 portable fire extinguisher.

v. A cut-off switch near the cabin for disconnecting the incoming power supply before entering or leaving the cabin, for operator safety.

vi. Foot operated rotary gong alarm at least 300 mm in diameter.

b) Walkways and Ladders

Ladders, platform, walkways, hand holds, etc., necessary to give safe access to and movement in the cage, bridge drive and trolley drive mechanisms and all other components of the crane needing inspection, maintenance and repair shall be provided. The walkways and ladders shall be in accordance with the following requirements:

i. Walkways to be of steel chequered plating for full bridge length, at same elevation as the bridge, attached to outside of each girders; width, clearance from drive units and head room to be minimum 700 , 500 and 2000 mm respectively.

ii. Steel ladders and stairs to have non-slip treads, not less than 600 mm wide between sides, preferably sloped forward, and provided with back safety guards in case height of ladders exceeds 3000 mm.

iii. Hand rails for walkways, platform, stairs, ladders, etc. , 1100 mm high, with an intermediate rail.

iv. Two plates on each side edge of all walkways of about 100 mm height.

v. A ladder shall be provided for access from service bay to operators cabin.

c) Safety Guards

Appropriate and effective safety guards, encasements, and covers shall be provided for various rotating components, and for live electrical conductors of the crane as below:

i. For gears, chain drives : Encasements.

ii. For revolving shafts & couplings : Guards for full lengths.

iii. For sheaves of hook block and rope : Guards to prevent trapping of hand, and to prevent rope from dismounting from sheave grooves even if rope slackening develops.

iv. For openings in foot walk floorings and other inspection platforms : Covers of lockable type.

22.2.4.8 Safety Lugs

Suitable safety lugs shall be provided to contain the movement of the crane during an earthquake. Clamps to keep the crane in locked condition while not in operation shall also be provided.

22.2.4.9 Name Plate

The crane shall have permanent main nameplates affixed to each side of the crane, so as to be clearly legible from the floor, showing

the name of the manufacturer and the rated capacity. In addition, each hoist shall have its rated capacity clearly marked on its block. These nameplates shall be in English.

22.2.5 MECHANICAL FEATURES AND PARTS OF CRANES

22.2.5.1 General

a) The Power House Crane, GIS Hall crane and BF Valve house crane shall conform to all requirements of Clauses mentioned in the Clause no. 22.3 "DESIGN CRITERIA FOR CRANE EQUIPMENTS".

b) The travel motion shall be equipped with automatic spring set, electrically-released, shoe type brakes. These brakes shall be applied automatically when the control lever of the master contract is in the "off" position and shall be capable of holding the crane stationary.

22.2.5.2 Bridge Travel Mechanism

a) For power house crane the mechanism shall comprise of four (4) electric motors and totally enclosed speed reduction helical gear units, two (2) for each end of the bridge, to drive the four (4) bridge wheels and shall ensure equal speed. For other cranes, the mechanism shall comprise of two electric motors. Alternatively for B.F. Valve house and GIS hall cranes, the bridge wheels on both sides can be driven with control drive system and controlling shaft.

b) The gear motors shall be keyed directly to the extended wheel shafts.

c) The bridge motion shall be free from vibrations and rocking under all conditions of operations and the crane structure shall not have any tendency to get out of line.

d) The coupling for the shafts of the motors, gear units and wheels shall be of safety flange type accurately faced and turned and shrunk into place with taper flush keys.

22.2.5.3 Trolley Travel Mechanism

This mechanism shall comprise of two (2) electric motors for Power House cranes and totally enclosed speed reduction gear units, one (1) for each end of the trolley to drive two (2) trolley wheels, designed to ensure equal speed and steady motion, free from vibrations and rocking. For B.F. Valve House and GIS Hall cranes,

motors can be two (2) or less and control drive system as mentioned in bridge travel mechanism can also be adopted.

22.2.5.4 Hoisting Mechanism for Raising and Lowering of Load

The hoisting mechanism provided and mounted on the crane trolley shall comprise of motors, speed reduction gear units, drums, brakes, lifting tackles and hooks, hoisting rope and slings as below :

a) Hoist Drive for Normal Speed

The hoist shall be driven by a motor through speed reduction gear units for normal speed of the hoist and shall be complete with brakes and retarding devices.

b) Hoist Drive for Micro Speed (Inching)

i. Gradual and very slow, accurate and controlled operation will be required to place the generator rotor and other heavy equipments very gently. The hoist shall have such provision by means of stepless, frequency converter speed control system, enabling control of the vertical motion of the hoist within 1 mm.

ii. In respect of power house cranes, the inching operation shall work for both individual as well as for tandem operation of the two cranes.

iii. The hoist machinery and lifting tackle for both hoists shall be so arranged that the center of lift does not shift in any direction throughout the full lift of the hoists.

c) Winding Drum

The trolley shall be provided with separate rope winding hoisting drum for main and auxiliary hoist for power house cranes. The winding drum shall have machined grooves to receive the full hoisting rope without overlapping. The hoisting drum shall be flanged or guarded and shall be not more than one layer of rope on the drum when the rope is in fully wound position and its length shall be such that each lead of rope has a minimum of two & half (2.5) full turns on the drum when the hook is in its lowest position and one spare groove for each rope lead off the drum when the hook is at its highest position. The drums shall be designed to withstand the maximum compressive stresses and local bending stresses in the drum at the grooves when the rope is wound on.

d) Lifting Tackles & Hooks

i. The lifting tackles shall consist of a safety type lower pulley block, hook, necessary sheaves and flexible steel wire rope. The lower block shall be a heavy steel housing to support the sheaves and hook.

ii. Sheaves shall be made of cast steel and shall be machine grooved to a depth of not less than one and a half (1.5) times the diameter of the rope. The groove shall be finished smooth and shall be free from surface defects likely to injure the rope. The sheaves shall be provided with guards to retain the rope in grooves and other requirements of sheaves shall be as per approved relevant standards. The contour at the bottom of the groove shall be circular. The radius of this part of the groove shall be larger than the radius of the rope but not less than the appropriate amount given on relevant IEC publications. The angle between the rope and plane perpendicular to the axes of the pulley shall not exceed 5 degrees .

iii. The swiveling hook shall be of forged steel and mounted on ball thrust bearings and protective skirt shall be provided to enclose the bearings.

iv. The main hook shall be of the Ramshorn type conforming to approved relevant standards (IS:5749) and the auxiliary hook shall be of shank type conforming to IS : 3815.

e) Hoisting Ropes & Slings

i. The hoisting rope shall be of the type as specified in Clause 22.3.5.19 of Section-22.3 of these specifications. The factor of safety for the hoisting ropes shall be not less than six (6). The rope system shall be equalized and arrangements entailing reverse bends shall be avoided as far as possible.

ii. The offer shall include requisite wire rope slings of suitable lengths having a safety factor of not less than six (6) while lifting specified load with the angle formed at the hook not less than 90 degrees. **A minimum of two pairs shall be provided for different loads up to the rated capacity of main hoist for each of the four numbers of cranes under scope of supply. The slings shall be suitable for use with hoist**.

iii. Each sling shall have a ring at one end and a ring or a hard eye at the other, with matching shackle for the hard eye. Sling rings are to be suitably proportioned to fit on the crane hook.

iv. A wall chart shall be provided showing the maximum safe lift of the slings individually and in pairs at various angles. Each sling and shackle shall have a permanent fixed label on which is stamped the maximum safe lift at 90 degree spread. **A storage rack each for safe keeping of the slings separately for each of the three categories of EOT cranes shall also be supplied.**

22.2.5.5 Brakes for Various Drives / Motors

A) The brakes for various motion drives shall be as per the IS : 3177. The following type of brakes shall be provided for the various crane drives:

a) Bridge Travel	i)	Main Braking by means of frequency speed control of motors down to zero (0) (regenerative braking).
	ii)	Automatic DC electro-magnetic brake for each motor drive.
	iii)	Foot actuated hydraulically operated brakes for wheels on both sides of bridge of double (2) brake discs.
b) Trolley Travel	i)	Main braking by means of frequency Speed control of motors down to zero (0) (regenerative braking).
	ii)	Automatic DC electro-magnetic brake for each motor drive.
	iii)	Automatic Electro-Hydraulic thruster brakes.

c) Hoisting Motion

For Main Hoist:

i) Main braking by means of frequency speed control of motors down to zero (0) (regenerative braking).

ii) Automatic DC electro-magnetic brake for each motor drive

iii) Automatic electro hydraulic thruster brake

For Auxiliary Hoist for Power House and B.F. Valve house crane:

i) Main braking by means of frequency speed control of motors down to zero (0) (regenerative braking).

ii) Automatic DC electro-magnetic brake for each motor drive.

iii) Automatic electro hydraulic thruster brake or double brake discs.

B) The electromagnetic brakes shall be of DC type complete with rectifier equipment to convert the available AC 230 V, 50 Hz supply. The electro-hydraulic thruster brakes shall be of AC type.

C) **The operating solenoids of the DC Electro-magnetic brakes shall release the brakes on energisation and shall automatically apply all the brakes immediately in the event of stoppage, interruption or failure of electrical power supply**. The brakes shall also apply immediately on operating the emergency stop push button or switch irrespective of controller position.

D) The DC Electro-magnetic brakes shall be of spring set shoe type equally effective in both directions of rotation. The springs for the Electro-magnetic brakes shall be of compression type and shall have adequate factor of safety.

E) The brake system shall have the following provisions:

a) Locking device in the brake lever.

b) Means for adjustment to compensate for wear of the shoes / discs.

c) Emergency stop push buttons.

F) The wearing surfaces of all brake drums shall be machined and shall be cylindrically smooth and free from defects. The brake lining shall be effectively and permanently secured to the brake shoes during the effective life of the lining and shall be protected from water, grease, oil and other adverse effects. The brake pedals in case of foot operated brakes shall have non-slip surfaces and it shall be possible to **apply the foot brakes with a force not exceeding 25 kg.**

G) All the brakes shall have adequate capacity. The brakes for hoisting when applied shall arrest the motion and sustain the load up to the test load at any position of the lift. **Provision shall be made to control with safety the lowering of any load up to the test load.**

H) Brakes in other motions shall be capable of bringing the relevant motions of the fully loaded crane safely to rest in the shortest possible time with least possible shock and shall arrest the motion under all other service conditions.

I) The various brakes shall be designed to exert, the torque equal to 1.5 times the full load torque of motors.

J) The brake torques may be increased if considered necessary by the supplier in order to ensure proper and safe application of the brakes. All Electro-magnetic brake coils shall have continuous rating.

K) Each brake of the travel motions shall be equipped with a manual disconnect lever which will allow the brakes to be released without electrical power.

22.2.5.6 Gears

The gears, and the gear trains for reduction of speeds of the motors for various motions of the cranes shall be designed, manufactured / fabricated and shall have following provisions:

a) Only spur and helical gears shall be used for speed reduction gearing. The tooth profiles are to be carefully designed and machined.

b) The gears having speeds higher than 500 rpm shall be of helical teeth type with active contact area hardened to a depth of 0.2 to 0.3 mm.

c) Shall be made of cast steel or forged steel and designed as per IS: 4460 for the specified crane duty.

d) Shall be totally enclosed in oil tight gear box cases which shall be fabricated from tested quality steel plates and duly stress relived. Casing shall be effectively sealed against oil leakage.

e) Shall have Inspection covers on the top of the gear case for quick and easy inspection of gears and for adding oil in the gear case.

f) Adequate breathing and drainage facilities on all gear cases.

g) An oil level indicator.

h) Proper guards for uncased gears.

i) Markings of pitch line on all gears for facilitating erection.

22.2.5.7 Shaft

All shafts shall be designed and made in accordance with the following:

a) Material - High tensile rolled steel or forged steel.

b) Shaft diameter to take into account the provision of key slot & splines. Slot bottom shall have proper radius.

c) Where needed designed with suitable shoulders / step-up diameter for carrying and fitting of gears, pinions and similar parts.

d) Provision of fillets of ample radius at all diametral changes in sections.

e) Designed to limit shaft deflection to within 1/3000th of the span between bearings.

22.2.5.8 Bearings

All bearings shall be designed and provided in accordance with the following:

a) Provide antifriction / roller, ball or bush (sleeve) journal type as applicable for components as per sound practice.

b) Bearings shall be located close to the points of loading and shall be easily replaceable type.

c) The bearing preferably shall be of self lubricated type.

d) Bearings at shaft ends shall be sealed appropriately so as to be drip proof in case of oil lubrication.

e) In case of grease lubrication type, open ends of bearings to be appropriately sealed with grease retainers.

f) All bearings shall be designed so as to replaceable easily.

22.2.5.9 Lubrication Arrangement of Bearings

Lubrication arrangement of bearings, journals, ball & roller bearings in case bearings are not self lubricated type shall comprise the following :

a) Pressure lubrication system comprising gun for lubrication of all easily accessible grease type bearings with grease nipples.

b) Centralized hand operated lubrication system comprising pump and grease pipelines of copper or brass for bearings not easily accessible e.g. end carriage wheels. For reliability, distribution lines shall be double lines, ensuring continuous lubrication, in case one line gets choked.

c) Provision to prevent development of excess lubrication pressure at the bearings.

d) Gear trains shall be lubricated by oil bath. Sleeve bearings shall be oil lubricated type.

e) Initial lubrication of crane before handing over shall be supplier's responsibility which shall be done in the presence of purchaser.

f) Portable hand operated lubrication equipment viz. grease gun etc. shall be included in the supply.

g) Specification and details of lubricants shall be furnished by supplier. The brands of oil / grease used above shall be stated.

h) A lubricating chart shall be provided indicating all the lubricating points, the type of lubricants and recommended frequency of lubrication.

22.2.5.10 Drip Pans and Covers

a) All bearings and gear cases shall be made oil tight. Suitable drip pans shall be provided to collect oil and grease which may drip from bearings, gear cases and other components of the crane. In case drip proof arrangement is not possible, means for cleaning the drip pans shall be available.

b) Dust covers shall be provided where necessary to protect sliding and rotating parts and to prevent dust from mixing with the lubrication.

22.2.5.11 Bumpers

Resilient / spring bumpers shall be attached to the bridge trucks and the trolley. The bridge shall have four bumpers one at each corner, arranged to meet the crane stops squarely. The trolley shall have two bumpers on each side placed to meet the track stops squarely at the end of the stops. The bumpers shall be capable to absorb safely the kinetic energy and shall be capable of bringing the crane and the trolley to a gradual stop when travelling at rated speed in either direction, when the power supply is suddenly cut-off and thus, eliminate excessive stresses and damage to any part of the crane.

22.2.6 ELECTRICAL FEATURES AND PARTS OF CRANES

22.2.6.1 General

a) The electrical drives, switchgear and controls for various motions for the cranes shall comprise of electric motors of requisite capacities for specified duties and speeds, switches, breakers, resistors, electromagnet brakes, isolating switches, controllers, earthing, cabling / wiring, in accordance with the latest version of IS : 3177.

b) The power supply for the electrical equipment shall be 415 V, 3 phase, 4 wire, 50 Hz AC. The supply for crane control and lighting shall be 230 V, 1 phase, 50 Hz AC and shall be obtained through individual 415 / 240 V transformers, wherever necessary. These transformers shall be part of crane supply. All electrical equipment shall be suitably designed and constructed for operation under tropical conditions.

c) Permissible temperature rise of the electric motors and individual components of associated switchgear equipment shall be as prescribed in the Indian standards and shall be based on ambient temperature of 35.5 deg. C

d) The electrical control, operating mechanisms and devices shall be located and arranged in neat and convenient manner which shall be subjected to the approval of the purchaser. Crane control levers, motors, switches and other operating mechanism shall be marked plainly and permanently.

e) The technical particulars of various electrical equipment and devices shall be as specified here in. The supplier shall furnish the make, type and other relevant details of the electrical equipment devices, being offered by them.

f) Frequency converter drive for power house cranes and B.F. Valve house cranes.

Description

Equipment for controlling this drive shall be a multi drive system, with inverters in one cabinet. Each cabinet consists of one common rectifier with a common DC-bus, with inverters connected. This system will, in case braking energy is being supplied from one motor, supply the energy to the next motor connected to the DC-bus. If the braking energy exceeds the energy used by the other inverters, a braking chopper will open, and supply the energy to a braking resistor.

It is a vector controlled frequency converter, which means it can drive a motor through 0 revolutions at full torque. To achieve this a Pulse encoder (Tacho) is used at the motor to control the flux and phase shift, in order to obtain the exact position of the rotor.

All frequency converters shall be connected to application process controller (APC), where all controls on the frequency

converters shall be done. The APC shall programme the application to fit the required specifications.

The APC shall also be also provided with communication controllers to other systems, or frequency converters. In tandem drive applications communication shall be done through these serial communication channels, in order to obtain exact common speed for the two systems.

The control shall be closed loop vector control system.

Functional Description

Each movement of the crane motors is controlled by joysticks in the crane control cabin. Motors are controlled by the APC in the frequency converter cubicle. The APC gets the direction / speed signals from the joystick. The APC calculates the speed and torque, in order to secure correct speed.

When stopping the operation of hoisting or lowering, the APC performs commands to the frequency converter, for lowering the speed to zero, and keeping it at zero speed before giving order to turn on the brake. When starting the operation of lowering or hoisting, the APC controls the frequency converter with a certain torque before releasing the brake, in order to avoid any drop.

If the braking energy exceeds the energy of all the frequency converters, the braking chopper will open and use the braking resistor.

When being in “position Mode", the joystick signal is being disabled and only joystick movement signal is being used.

When the crane operator moves the joystick forward, the crane will move only over a predefined distance, and stop. To move an additional step he will have to move the joystick once more etc.

When being in "Tandem Drive Mode" , both cranes of power house are connected together mechanically as well as electrically. The APC is now controlling the system such that only one crane cabin is the master. The "Master" system is now controlling both cranes through a serial communication line between both APCs. All movements are now controlled from the "Master Cabin". Fault messages will come up in a display in the crane cabin. Switches for turning on the frequency converters are located in the crane cabin.

22.2.6.2 Detailed Specifications of Individual Equipment

a) Motor for Various Motions

i) Motor Standards	As per IS: 325 and IS: 3177
ii) Capacity	Of ample capacity to suit respective duties. Full load torque of motors shall be higher than the maximum load torque.
iii) Type and Enclosures	All motors will be of squirrel cage type to suit 415 V, AC, 3 phase, 50 Hz, four wire power supply, totally enclosed. The motors shall be suitable for direct on line starting any hoisting / lowering rated load, even in event of frequency control system being out of order. Protection IP 54 with fan cooling arrangement for power house cranes and with or without fan cooling arrangement for B.F. valve house crane or GIS hall crane.
iv) Variation of supply Voltage & Frequency	Voltage: ± 10%, Frequency: ± 3%, Any combination values of voltage and frequency variations within the above limits.
v) Pull out torque (2.25)	Not less than Two point two five times the full load torque of motors at rated voltage and frequency.
vi) Insulation	Class - F
vii) Time rating	One (1) hour for all motors
viii) Temperature rating	Temperature rise not to exceed the limits in Table-1 of IS: 325. Max. temperature rise at full load measured by resistance method

		shall not exceed 60 deg. C over the maximum ambient temp. of 35.5° C.
ix)	Rated synchronous speed	To suit duty for various motions
x)	Over speed withstand speed or capacity less	Two point five (2.5) times rated 2000 rpm whichever is
xi)	Space heaters capacity is	To be provided in case motor ≥ 20 KW (To suit 240 V, AC supply)
xii)	Motor bearings grease	Roller type. Sealed to prevent leakage and entry of dust. Shall be of ample strength to withstand heavy shocks and vibration to which subjected under all conditions of operation.
xiii)	Tests IS: 325.	Type & routine tests as per Copies of test reports to be furnished by the supplier
xiv)	Temperature rise measurement	By resistance method
xv)	Climate climate.	Shall be located indoor in tropical Protection against fungus, vermin, and corrosion shall be provided
xvi)	Terminal terminals are	Shall be arranged such that easily accessible for inspection and maintenance. Natural ventilation shall not be restricted
xvii)	General requirements operational	Sturdy and strong to withstand shocks and vibrations

b) Limit Switches

i) Limit switches for hoisting motion shall be spindle type, while for bridge and trolley motions, these shall be of lever / roller and proximity type with maintained contacts. The number of limit switches shall be as under:

Motion / Emergency Travel	Travel	Raising	Lowering	'up' limit
Main Hoist	-	1	1	1
Auxiliary Hoist	-	1	1	1
Bridge (Two-way self-resetting type)	2	-	-	-
Trolley (Two-way self-resetting type)	2	-	-	-
Mono rail Hoist	-	1	1	-
Mono rail Travel (Two-way self-resetting type)	2	-	-	-

ii) Type, contact rating and resetting of limit switches shall respectively be totally enclosed type, 5 A at 240 V AC, by reversing the controller.

iii) Electromagnetic Braking is provided for Mono rail crane.

22.2.6.3 Load Cell System

a) The main and auxiliary hoists on the Powerhouse crane as also the B.F. Valve House Crane shall be equipped with a load cell system capable of measuring the load on their hooks. The load cell system shall measure loads from 0 to 130% of the hoists rated capacity with a precision of ± 5% or better, between the effective and the indicated loads, for all loads between 0 and 130% of the rated load of the hoists.

b) The load cell shall be of corrosion-resistant steel construction and shall be designed with a factor of safety of not less than four (4) at 130% of the rated hoists capacity, relative to the ultimate strength of the material.

c) The load cell system shall operate from the crane's AC power supply and shall display the load on the hooks in tons through a 3-digit display or meter readout located at the stand-by station.

d) The load cell system shall incorporate a capacity limiting feature which will prevent the crane from handling a load which exceeds a set point by stopping all crane motions. This point shall be adjustable for any load between 90% and 120% of the hoists rated capacity. Whenever this feature stops the crane, a flashing red light, visible from the floor beneath the crane, shall be energized, to indicate that the crane is overloaded. An override switch shall be provided in the radio control transmitter to allow for overload tests. The response of this capacity limiting feature shall be suitably delayed to compensate for the momentary, dynamic loading when the hoist's motors are started.

22.3 DESIGN CRITERIA FOR CRANE EQUIPMENTS

22.3.1 GENERAL DESIGN CRITERIA

22.3.1.1 General

a) The cranes shall be class -2 duty type and shall be designed in compliance with requirements of latest version of IS:807 and IS:3177. Where requirements contained in the latest applicable ISS are stricter than those contained herein, the ISS requirements shall govern.
b) The cranes shall be supplied in accordance with the requirements of these specifications including the limiting and / or mandatory dimensions as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". All details shall be determined by the supplier subject to customer's approval.
c) Any design feature or detail not specified herein shall be in accordance with IS: 807 and IS: 3177 or other equivalent approved standards which shall supplement these specifications.

22.3.1.2 Safety Requirements

In the design of the cranes, all safety regulations provided under the Factory Act, Indian Electricity Act and other applicable legislations shall be taken into consideration and provided for.

22.3.1.3 Splices and Connections

a) Shop Splices

All shop splices and connections shall be either welded or shall be made with ribbed, fitted, or high-strength steel bolts and

self-locking nuts, as applicable. Main members shall be assembled in the shop prior to reaming or drilling of holes for field connections.

b) Field Splices

Field connections shall be made either with ribbed or fitted bolts and self-locking nuts or with high-strength steel bolts; **field welding will not be allowed.** Shop assembled parts dismantled for shipping shall be clearly match-marked for field assembly. Field-bolted structural connection between girders and trucks shall be made with fitted bolts. Field-bolted connection between girder sections shall be made with high-strength steel bolts. All high-strength bolt connections shall use a sufficient quantity of fitted bolts to ensure proper alignment.

c) Lubricants

Grease, lubricating oil, and hydraulic brake fluid required for initial filling of all the equipment plus ten percent (10%) reserve shall be furnished with each crane. This amount is exclusive of any oil or grease required for flushing or otherwise preparing the equipment for operation which shall also be provided. The selected materials for gears, bearings, and other items that come in contact with the oil or grease shall be compatible with the specified lubricants. **The hydraulic brake fluid may be selected by the supplier subject to approval by the customer.**

22.3.2 ALLOWABLE STRESSES

22.3.2.1 General

The maximum allowable stresses in materials used for various parts of the equipment are specified herein. However, the supplier shall be responsible for an adequate design based on factors proven in practice and shall use lower working stresses where conditions indicate.

22.3.2.2 Maximum Allowable Stresses

a) General

Adequate factors of safety shall be used throughout the design, especially in the design of parts subject to alternating stresses, vibration, impact, or shock.

b) Structural Members (Including Bridge Girders)

i. Normal Loading Conditions. Under normal loading conditions maximum shear stresses in cast iron shall not exceed 10% of the ultimate tensile strength. Maximum shear stresses in other ferrous materials shall not exceed 60% of the allowable stresses in tension. The maximum stresses in tension or compression shall not exceed 33% of the yield strength or 20% of the ultimate tensile strength.

ii. Seismic Load Condition. The maximum stresses shall not exceed 80% of the minimum yield strength of the material used.

iii. The carne & its structural components shall be designed in accordance with the appropriate clauses in Section IV of IS: 800, & IS: 806.

iv. The crane & its structural member shall be proportioned in such a way that the actual stresses, for the combination of loading causing most adverse effect on the members, shall not exceed the lower of the value given as below:

- Basic stress derived form IS: 800, IS: 806 & IS: 816, as applicable, multiplied by the duty factors given in IS: 807.
- Permissible stresses in members subject to fluctuations of stress determined according to the provisions laid down in IS: 807.

c) Mechanical Components, Shafts and Pins

The working stresses, bearing pressures, and other design criteria for the mechanical components shall be based on consideration of functional requirements, dynamic loadings, impact, and stress concentration effects. Stresses computed for rated load capacity in no case shall exceed 20% of the ultimate strength of the materials involved. Under seismic load conditions, the stresses shall not exceed 80% of the minimum yield strength of the materials used.

d) Wire Ropes

All wire hoisting ropes shall be selected on the basis of a factor of safety not less than six (6) based on the nominal breaking strength considering the weight of the rated load, load blocks, and lifting beam (if any) and considering the overall efficiency of the hoist reeving.

22.3.3 LOADING CONDITIONS

22.3.3.1 Loads

a) General

The definitions of the dead, live load, etc. shall be as given in applicable design standards, except as stated herein. All loading cases shall consider the trolley and / or live load in the position which causes the greatest stress.

b) Dead Load

The weight of all effective parts, the bridge structure, machinery parts and fixed equipment supported by the structure.

c) Live Load

Live loads shall include the weight of the ropes and lower load blocks.

d) Vertical Impact Load

Thirty two percent (32%) of the total live load.

e) Braking and Horizontal Loads & Longitudinal Loads

Loads due to the sudden application of the bridge and trolley travel brakes shall be taken as the forces produced by locking the driven wheels with the crane carrying the rated load. The coefficient of friction for braking loads shall be taken as 0.15 in which case all driven wheels shall slide on the rail. The coefficient of friction for tractive conditions shall be taken as 0.09 in which case no wheel shall slide on the rail.

The horizontal forces resulting from the acceleration or deceleration of the trolley tractive effort and bridge tractive effort shall be as follows :

i) As transverse load of Ten percent (10%) of the weight of trolley with rated load in such a position as to produce maximum stress due to moment or shear in the girders, applied equally on the two trolley rails.

ii) A longitudinal load of Ten percent (10%) of the total weight of the bridge less the weight of track wheels and trucks.

f) Earth-quake load

These shall be derived based on seismic accelerations as specified in Volume-1 of these specifications.

g) Walkway Load

All walkways shall be designed for a live load of 250 kg/m^2 in addition to the weight of any equipment mounted thereon. All handrails shall be designed to withstand a 50kg horizontal load for every 1.0 m of top rail.

h) Crane shall be tested at rated and over load capacity in shop as per relevant
standard and at site also. All arrangements included load shall be made by the Contractor.

22.3.3.2 Seismic Design Criteria

a) General

Each crane shall be designed and constructed to withstand the earthquake loading defined in this section. Stresses in the crane and trolley structure shall be analyzed according to the conditions specified herein. All equipment of the crane, such as bearing pedestals, machinery parts, components, and controls, shall be designed and fastened so that they do not suffer damage or misalignment and to permit operation of the crane without repairs following an earthquake.

b) Seismic Loading Conditions

i. The loadings for the seismic conditions shall combine the dead load due to the weight of the completely equipped crane and trolley and the seismic loads in any one of the specified directions. For these loading conditions, the crane shall be considered standing still and without load on the hooks but with the lifting beam attached (where one is provided).

ii. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act nonconcurrently. For horizontal acceleration 0.4 g and vertical acceleration of 0.2g shall be considered for the calculation of seismic forces acting on the equipment during earthquake. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The following conditions shall also be considered :

- Horizontal seismic load reactions between rail and wheels, in the direction of traveling, shall be limited by sliding of the wheels, considering all braked wheels blocked with friction coefficient of 0.25 between rail and wheel.
- For upward vertical seismic loads, the weight of all parts shall be considered overcome by the earthquake and a 0.075g net upward force shall be considered acting.
- Horizontal seismic load reactions that are normal to the rails shall be considered distributed on the flanges of the wheels on one side of the crane. The positive upward vertical reactions shall be considered distributed over all rail clamps.

iii. A separate loading case shall be analyzed for the seismic acceleration in each of the following directions : horizontal parallel to the crane rail, horizontal normal to the crane rail (both directions), vertical downward, and vertical upward.

iv. For the seismic loading conditions, the allowable stresses for normal loading cases may be increased up to 80% of the minimum yield strength of the material, except for the design of the following parts for which the allowable stresses shall not be increased.

- Wheel flanges, rail clamps, and emergency guide shoes; and
- All bolts, pins, welds, and other means used for connecting above parts to the main structure and those used for mounting machinery parts, controls, or other hardware.

22.3.3.3 Overall Loadings for Crane Design

A. General

All the cranes and runway rails shall be designed for the specified combination of extreme loads acting on them during operation or standstill. Eccentricity of loading shall be taken into consideration in the design. The maximum stresses acting on the members of the cranes and runway rails shall not exceed the safe permissible stresses under any actual combination of loads.

The design of the crane shall also take into account the seismic forces as stated in this section and also specified under Volume-I of Tender Specifications.

B. Combination of Loadings on Crane

The crane shall be suitable for following conditions of loadings:

a) Crane stationary / load being hoisted / start of hoisting

i) Dead load + Live load + Vertical Impact load

ii) Dead load + forces caused by maximum or break down torque of the main hoist motor.

The resulting stresses shall not exceed Eighty percent (80%) of the yield point (elastic limit) of the materials of the members subjected under the loading.

b) Crane in motion

i) Dead load + Live load + any one horizontal load viz, lateral, longitudinal or specific design load.

ii) Dead load + braking load

iii) Dead load + Live load + any two (2) or more horizontal loads viz lateral, longitudinal or the specified design loads.

The resulting unit stresses due to above loads shall not exceed the safe stresses by more than thirty three (33%) percent of normal allowable stresses.

c) Crane Stationary

Dead load + earthquake load

The resulting stresses must not to exceed Thirty Three (33%) percent of normal allowable stresses.

22.3.4 STRUCTURAL DESIGN CRITERIA

22.3.4.1 General

All structural components shall be made from steel sections **not less than 6 mm thick**. All welds shall be continuous.

22.3.4.2 Girders

a) The crane girders shall be of welded structural steel-box section construction unless otherwise specified.

b) All crane girders shall be of proper width to ensure adequate lateral stiffness, shall be braced at each end, and shall be attached by ample gusset plates to the end trucks. The maximum vertical deflection of the crane girders resulting from the weight of the trolley plus the rated load shall not exceed 1/900 of the span of the crane. Girders shall be cambered an amount equal to the dead load deflection plus one half of the deflection caused by the design live load and trolley. In the design of girders the camber shall be nil or positive neutralizing the deflection.

c) Wherever possible, bridge crane girders shall be notched to rest on top of the end trucks and shall be connected to the end trucks with shelf angles and horizontal gusset plates of ample size to provide a stiff connection to the end truck. An adequate number of fitted bolts for reamed holes shall be provided for the end truck connection to accurately align the girders with the end truck during erection. Squaring marks shall be provided on each girder to facilitate erection and squaring of the bridge.

d) Suitable supports shall be provided at one end of the crane bridge for the placement of a temporary platform between the girders during crane erection and for use during the reeving and maintenance of the cranes trolley.

22.3.4.3 Trucks

a) Trucks for crane bridges shall be of the equalizing type which shall distribute the load evenly between the wheels. Trucks shall be of structural steel box section, heavily reinforced to provide a rigid structure and minimize deflection. The outside wheels on one side shall be spaced, center to center, not closer than 1/7 the span of the crane.

b) **Safety lugs shall be provided to prevent a drop of more than 2.5 mm, in case of a broken wheel or axle.** Truck wheels and safety lugs shall be designed to function properly on runway rails mounted as shown on the drawings. Trucks shall be equipped with rail sweeps, extending below the top of the rail and projecting in front of the truck wheels, which will push forward or off the track any object placed across the rail.

c) All trucks shall be designed to permit easy wheel removal. Jacking pads shall be provided on all trucks whenever the wheel reactions with no load on the hook exceed 6500 kg per wheel.

d) No part of the end truck shall project below the flange of the bridge wheel.

22.3.4.4 Trolley Frame

Trolley frames shall be of rigid, welded structural steel construction and shall provide equal distribution of the load on all wheels without excessive deflection. All machinery assemblies shall be mounted on machined surfaces. Shims may not be used except under brakes and motors. Trolleys shall be equipped with safety lugs, rail sweeps, and jacking pads as specified for trucks above. The trolley shall be completely floored-over without openings except as required for ropes.

22.3.4.5 Bumpers and Stops

a) Bumpers shall be rigidly mounted on end trucks and trolleys to contact bumper stops at both ends of each runway.

b) All bumpers shall be of the spring compression type except where the full load rated speed is less than 10 m / min. in which case they may be of elastomeric, hydraulic, or other shock absorbing material. Bumpers shall have sufficient energy absorbing capacity to stop the crane or trolley when traveling at 50% of the rated speed without exceeding the normal allowable stresses and to stop the crane or trolley when traveling at full rated speed without exceeding the yield strength of the materials involved.

c) All bumpers shall be designed so that there is no direct shear on bolts and shall be equipped with safety cables to prevent falling of parts from the crane in case of breakage.

d) Bumpers on bridge end trucks shall be capable of stopping the crane (not including lifted load) at a rate of deceleration not to exceed 10% of the acceleration of gravity when traveling in either direction at 20% of the rated speed.

e) Trolley bumpers shall be capable of stopping the trolley (not including lifted load) at a rate of deceleration not to exceed 15% of the acceleration of gravity when traveling in either direction at one-third of the rated speed.

f) In addition to the trolley bumpers specified above, all trolleys (including monorail trolleys) shall be provided with positive trolley stops at the limits of their travel. These stops shall be designed and fastened to resist the forces applied when contacted. **Stops engaging the tread of the wheel will not be acceptable.**

22.3.4.6 Walkways and Ladders

a) The access to the bridge walkway for maintenance or operation shall be from an access area as shown on the drawings and shall not require stepping over any gap exceeding 0.3 m. The crane shall be equipped with walkways and ladders to allow safe passage from the access point shown on the drawings to the following:

- All bridge walkways,
- The trolley, and
- Both crane corbels

b) Equipment on the crane shall be located so as to give safe access to all points that must be reached for maintenance or operation. Fixed ladders shall be in accordance with applicable standard.

c) A walkway shall be provided on both sides along the entire length of the bridge. Ladders, platforms, and steps shall be provided to permit access for lubrication, inspection, and maintenance, wherever necessary.

d) Walkways should preferably be located to give a headroom of not less than 2.0 m. but in no case it shall be less than 1.2 m.

e) All walkways and stairways shall be of rigid construction, with non-skid chequered plate treads or grating, toe-boards not less than 0.1 m high, and double-tiered structural steel handrails not less than 1.0 m high. Walkways shall be continuous and permanently secured. Walkways shall have a clear passageway at least 0.45m. wide except opposite the bridge motor where they shall be not less than 0.4m and except opposite electric cabinets where the passage shall not be less than 0.75m. Ladders shall be of steel construction with rungs welded to the ladder rails. Rails shall extend not less than 1.1 m. above the landing at the top, for safety in getting on or off the ladder, and shall start on a landing platform.

22.3.4.7 Seismic Requirements

a) Rail Clamps

Each crane truck shall have 2 sets of rail clamps, and the trolley shall have 2 sets of automatic rail clamps for each crane girder rail. The rail clamps shall secure the crane bridge and the trolley against upward motion caused by seismic forces. Each clamp shall have a prong under each side of the railhead. Similar rail clamps shall be provided on all monorail trolleys to withstand seismic forces.

b) Emergency Guide Shoes

Emergency guide shoes shall be provided to limit the lateral displacement of Crane Bridge and trolley so as to prevent derailing if wheel flanges are damaged.

c) Equipment Mountings

Crane components shall be securely mounted to the crane to withstand all normal and seismic loads. Fitted pins or welded locating lugs shall be used where required.

22.3.5 MECHANICAL DESIGN CRITERIA

22.3.5.1 General

All parts which can be worn or damaged by dust shall be totally enclosed in dustproof housings. All units and housings weighing more than 45 kg and all housing parts weighing more than 10 kg shall be provided with suitable lugs or eyebolts for handling. All bolts and capscrews shall be provided with lock washers or locknuts. All machined units shall be thoroughly cleaned to ensure that they are free of cuttings and other abrasive material.

22.3.5.2 Guards

a) Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating components which might constitute a hazard under normal operating conditions shall be guarded. Guards shall be fastened securely. Each guard shall be capable of supporting without permanent distortion the weight of a **80 kg person** unless the guard is located where it is impossible for a person to step on it.

b) If hoisting ropes run near enough to other parts to make fouling or chafing possible, guards shall be installed to prevent this condition. A guard shall be provided to prevent contact between bridge conductors and hoisting ropes if they could come into contact when the load block is swung 6 degrees from the normal vertical position.

22.3.5.3 Bridge Drive

a) Not less than 25% of the bridge wheels on each rail shall be driven. Bridge drive could be a single or dual or quadruple motor arrangement as best suited. All bridge drive gearing shall be enclosed in gear reduction housings and mounted on the bridge girder structure.

b) If a single motor drive arrangement is provided, the travel motor shall be mounted near the center of the bridge girder and connected through suitable gearing and line shafting to the driving wheels. Flexible couplings shall be provided at each output shaft of the gear reducer and also adjacent to the truck drive pinion or to the truck wheel shaft end.

c) If a dual motor drive arrangement is provided, the motors shall be located near each end of the bridge and connected to separate gear reduction units.

d) The driving mechanism shall be designed and constructed so that travel will be steady and free from objectionable vibration, sluing, and racking in any part of the structure at any speed and load combination up to and including the rated speed and load.

e) All gear reducers and drive mechanisms shall be designed and located to enable easy bridge wheel replacement within the confines of the powerhouse or other space limitations shown on the drawings.

22.3.5.4 Trolley Drive Mechanism

Trolley drive could be a single or dual motor arrangement as best suited. The trolley drive motor shall be mounted on the trolley frame and connected to at least one driving wheel on each side of the trolley through gearing and shafting. Flexible couplings shall be provided at each output shaft of the gear reducer and near the trolley drive wheel.

22.3.5.5 Hoists

All hoists shall be mounted on a trolley frame, and each shall be driven by a suitable motor and gears to obtain the required hoisting speeds. The tangent of the maximum lead angel of wire ropes relative to drums and sheaves shall not exceed 1/12 unless sufficient evidence is submitted to justify a greater angle. Hoists shall not utilize cross-reeving rope arrangements. Equalizers shall be included to assure that the tension in the ropes is equalized.

22.3.5.6 Wheels

All wheels (except those of the monorail hoist) shall be double flanged, made from forged or rolled steel wheel blanks, and accurately turned or ground to the required diameters. All bridge and trolley wheels shall be doubly supported with a bearing on each side of the wheel. Cantilevered wheel arrangements are not acceptable. Drive wheels shall be matched pairs with less than 0.25 mm difference in diameters. Wheels shall be designed to carry the maximum rated load under normal conditions without excessive wear. Maximum wheel loads shall be as given in applicable standard specification unless otherwise approved. All wheel flanges shall be not less than 25 mm high, and where seismic design criteria apply, they shall extend not less than 15 mm below the top of the rails head when the wheel is lifted free of the rail so that the rail clamps contact the underside of the rail head. Wheel flanges shall have adequate-strength to resist the specified earthquake loads without exceeding the allowable stresses for normal operation.

22.3.5.7 Axles

The axles shall be heat-treated steel forgings, accurately turned and ground. Rotating axles shall be fitted to the wheels with a force fit. Driving wheels shall be keyed to the rotating axle in addition to the force fit.

22.3.5.8 Mechanical Brakes

a) General

i. All mechanical brakes shall be spring set shoe type brakes which shall be released electrically (except as noted in paragraph 'ii' below). All brakes shall have ample thermal capacity for the frequency of operation required by the application and shall be adjustable to compensate for lining wear. The friction surfaces of all brake drums, wheels, and discs shall be free of defects that interfere with operation.

ii. Electrically-released mechanical brakes shall be operated through a D.C. activated magnet. The D.C. power shall be provided by a rectifier. Electrically-released brakes shall become automatically effective when power to the drive motor is removed, except that holding brakes on the bridge or trolley drives shall not prohibit the use of a drift point in the control circuit. All brakes on traveling motions shall be selected for 1-hr intermittent duty and shall be equally effective in both directions of movement. All holding brakes on hoist motions shall be designed for continuous duty. Magnets for all brakes shall be rated for continuous duty.

b) Bridge and Trolley

An electric release mechanical brake shall be provided for each bridge and trolley drive motor. The brake shall have a capacity not less than 100% of the full load torque of the bridge or trolley drive motor and shall be of sufficient size to stop the bridge or trolley within a distance equal to that traveled in 6 seconds at full speed with full load.

c) Hoists

Each hoist shall be furnished with Two (2) electrically-released mechanical holding brakes; each rated not less than 100% of the full load torque of the motor. One brake shall be mounted on the motor shaft, and the other shall be mounted on the opposite side of the gear case.

22.3.5.9 Sheaves

a) Rope sheaves shall be of cast steel or welded steel construction with machined rope grooves.

b) The pitch diameter for running and idler sheaves shall be not less than 24 times the outside rope diameter when 6 x 37 class rope is furnished or 30 times the rope diameter when 6 x 19 class rope is furnished.

c) Sheave grooves shall be smooth and free from surface defects which could cause rope damage. The cross sectional radius at the bottom of the groove shall be such as to form a close fitting saddle for the size of rope used, and the sides of the groove shall be tapered outward to facilitate entrance of the rope into the groove. Flange corners shall be rounded, and the rims shall run true about the axis of rotation.

d) The sheave pins shall be made of annealed carbon or alloy steel (except as otherwise specified). All revolving sheaves shall be equipped with standard replaceable roller bearings with dust seals. The load sheave rpm at full rated speed shall be used to size all sheave bearings. Each sheave shall be lubricated by an individual grease fitting. All revolving sheaves shall be statically balanced.

e) Drums, sheaves, bottom blocks, and hoisting rope shall be designed so that when raising or lowering no crossover reaving will occur. Idler sheave arrangements shall be designed to minimize any twist in the rope.

22.3.5.10 Load Blocks

Load blocks shall be provided with close-fitting guards or other suitable devices to prevent ropes from becoming wedged in small openings when the ropes are momentarily unloaded and to guide the rope back into the groove when the load is applied again. The guards shall be of cast steel or welded construction and shall be fitted close to the periphery of the sheaves.

22.3.5.11 Hooks

a) Hooks and lifting eyes shall be made of forged annealed alloy or carbon steel. All hooks and lifting eyes shall swivel freely on grease lubricated roller or ball bearings and all hook beams shall be able to rotate. Bearings shall be totally enclosed, dust-tight, and constructed to prevent grease leakage. Load on roller bearings shall not exceed the static bearing capacity established by the bearing manufacturer, using a load factor of 1.0.

b) Hooks shall be designed such that the resultant load on the hook passes through the centerline of the shank. The maximum stress in the hook at its rated load shall not exceed 20% of the ultimate strength of the material.

c) Elevations specified for hooks refer to the bottom of the valley of the hook.

d) Prior to machining, all hooks shall be given an ultrasonic test and a wet magnetic particle inspection of all surfaces of the forging in accordance with applicable Indian standards specifications.

e) After machining, all machine surfaces shall be given either a wet magnetic particle inspection as above or a dry magnetic

particle inspection in accordance with applicable Indian standard specifications.

f) All cracks, linear indications, or aligned porosity exceeding 6 mm in length are unacceptable and shall be rejected or repaired in an approved manner. All repairs shall be re-inspected using both ultrasonic and wet magnetic particle inspection.

g) All hooks shall be buffed and center punched with a low stress center punch on the hook tops. The hooks shall also be center punched for recording the original dimensions of the throat opening measurements and later during the crane tests.

22.3.5.12 Hoist drums

Hoist drums shall be made of cast steel or welded steel of sufficient strength to sustain the combined crushing and bending loads of the rope pull. Allowance shall be made for fabrication and machining tolerances to assure adequate drum shell thickness under the machined groove. Each drum shall have right-hand and left-hand machined grooves to receive the hoisting rope. Grooves shall be smooth and well rounded. Grooves shall have minimum depth of 0.35 times the rope diameter. The minimum groove pitch shall be the rope diameter plus 3 mm. The drums shall be designed so that not less than 2.5 wraps of each part of hoisting rope will remain in the grooves when the hook is at the lowest position for the lift specified and atleast ¾ reserve turn is available, without overlapping of the rope, when the block is in the uppermost position corresponding to tripping of the block operated limit switch. The pitch diameter of the drums shall be not less than 24 times the rope diameter when 6 x 37 class rope in furnished and 30 times the rope diameter when 6 x 19 class rope is furnished. Drum flange height shall be not less than 2.5 times the rope diameter and shall be arranged so as to prevent the rope from touching gears.

22.3.5.13 Shafting

Shafts shall be machined to close tolerances at bearing and gearing fits. Shafting shall be of rolled or forged steel, amply supported to prevent excessive deflection.

22.3.5.14 Gearing

a) Gears shall be of the worm, helical, bevel, herringbone, or spur type. Herringbone gearing shall be of the continuous

type. Worms and pinions shall be made of forged carbon or alloy steel. Gears shall be designed in accordance with applicable standards.

b) Gear cases shall be oil tight and sealed. Input and output shafts of gear cases shall have seals to prevent oil leakage. The top section of each gear case shall be easily removable for inspection. Openings shall be provided in the top section for inspection of the gearing at the mesh lines. Covers for these inspection Openings shall be sealed to prevent oil leakage. Gear cases shall be made of cast steel or welded steel and shall have drain plugs, breathers ,and oil level gauges. Gear cases shall be mounted on machined surfaces. Shims shall not be used .All Gears shall have guards to prevent injury to anyone while the gears are in service.

c) Magnetic particle and dye penetrant inspections shall be performed, as applicable on the load holding gear trains of all hoist .These test shall be performed in accordance with the applicable ISS Code.

22.3.5.15 Bearings

Bearings shall be of the ball or roller type, except as otherwise specified ,and shall be designed to permit easy removal of the shaft. Bridge and trolley wheel bearings shall be of the roller type .Bearings shall be designed to exclude dirt, prevent leakage of oil or grease, and to eliminate the need for frequent lubrication .Shaft Bearings shall be placed as close as possible to points of loading. Bearings shall be easily replaceable. Bearing housings shall be of cast steel, or welded steel construction. **The service life of all bearings shall be not less than 10,000 hours at the design speed and power**. These service hours shall represent the life that 90% of the bearings will complete or exceed.

22.3.5.16 Lubrication

a) Provisions shall be made for proper lubrication of all parts. High speed gears and pinions shall be provided with forced oil lubrication. Low-speed drum gears shall be lubricated by soft grease or as recommended by the gear manufacturer.

b) Bearings shall be provided with means of pressure lubrication. The crane shall be provided with all necessary lubrication fittings. Lubricating points shall be located for easy and safe access without the necessity of removing guards or other parts. Lubrication lines shall be securely fastened to the cranes structure and shall be located to provide the

maximum protection and so that ordinary repairs can be made without removing the lines.

c) The crane shall be provided with a centralized lubrication system of reputed make. This system shall be manually operated, complete with a manual pump, reservoir, supply lines, metering valves, and discharge lines to all bearings. Either one system, mounted on the crane bridge with a quick/disconnect fitting on the supply line for connection to a flexible hose leading to the trolley, or two separate lubricating systems, one for the bridge and one for the trolley, shall be provided. Metering valves with indicators shall be provided for all points of grease application and shall be mounted at readily visible and accessible locations. All piping shall be made of suitable polymer, with flexible hoses where required.

22.3.5.17 Couplings

Couplings shall be of the flanged type with recessed bolts or suitable guards. Couplings shall be designed so that their strength equals the shaft strength and shall be of the flexible, spacer, or geared type.

22.3.5.18 Keyways

Connections subject to torsion such as couplings, driving wheels, and drive gears shall be keyed to the shafts with rectangular keys. The keys shall be sized to be within safe bearing and shearing limits of the materials in contact.

22.3.5.19 Wire Rope

Each rope of stainless steel shall be of sufficient length to provide the specified lift, the additional wraps, and the length required for mounting the rope. The rope shall be of 6x19 or 6x37 class or equivalent or better type with independent wire rope core and regular lay construction, unless otherwise approved. Rope ends shall be anchored by clamps securely attached to the drum so that the connection provides a safety factor of not less than 6 with only 2 wraps on the drum or by an approved socket arrangement. Socketing shall be done in the manner specified by the manufacturer of the socket assembly. Eye splices shall be made in an approved manner and rope thimbles shall be used in the eye. Rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope. Spacing and number of all types of clips shall be in accordance with the clip manufacturer's recommendation. Clips shall be of forged steel. Swaged or

compressed fittings shall be applied as recommended by the manufacturer of the fittings.

22.3.5.20 Bolts & Nuts

Metric Bolts and nuts for mechanical equipment shall be semi-finished and shall have hexagonal heads. Nuts shall be secured by effective lock-nuts or other approved locking devices.

22.3.6 CONTROLS

22.3.6.1 General

a) The Power House Cranes and Butterfly valve crane shall be designed for operation from operator's cabin and from Pendant Control System whereas the GIS Hall crane shall be designed for operation from Pendant Control System only.

b) All electrical equipment shall be suitably enclosed so that live parts will not be exposed to accidental contact under normal operating conditions. All master control switches, manually operated switches, circuit breakers, starters, contactors, limit switches and relays shall be clearly and permanently identified by attached nameplates. Emergency Push button shall be provided in operator cabin as well as on pendant control for emergency tripping.

c) All hoist controls and brakes shall provide for limiting the vertical movement of the hooks, with rated load and when starting from stand-still, **within increments of 1.0 mm.**

c) The controls and brakes shall limit the movement of the bridge and trolley, under the above operating conditions, **within increments of 3 mm. and 6 mm. respectively.**

22.3.6.2 Speed Regulation

a) **General**: Speed regulation shall be accomplished utilizing a **static step less control system** for all crane motions.

b) The hoist and travel motions shall be provided with stepless speed-regulations from **5 to 100% of rated speed**. Hoist control shall be achieved by adjusting the frequency of the motor electrical supply.

c) The maximum acceleration produced by the control system shall be independent of the rate of change of the control lever position.

d) The speed in the first lowering position shall not exceed 5% of the synchronous hoist speed when lowering any load up to rated load.

e) The speed in the first hoisting position when lifting any load up to 125% of rated hoist capacity **shall not exceed 5% of the synchronous hoist speed.**

22.3.6.3 Control System Details

a) Bridge and Trolley Travel:

Each travel motion shall have a separate control lever or set of pushbuttons.

b) Hoists

i. General: Separate controllers shall be provided for each hoist. Smooth acceleration shall be provided for all loads in both directions.

ii. Lowering: The lowering speeds for all loads within the rated capacity shall be gradually increased by advancing the controller from the 'off' position toward the 'full-on' lowering position. The lowering speed shall not exceed 125% of the rated speed on any control position.

iii) Hoisting: The hoisting speeds for all loads within the rated, capacity shall be smoothly increased by advancing the controller from the 'off' position toward the full-speed hoisting position. In no case shall any load up to 130% of rated capacity cause a hoist to lower when the controller is in any raising position

c) Control Levers and Pushbuttons

i. All lever-operated controls shall have self-resetting controllers provided with a notch or latch which in the "off" position prevents the handle from being inadvertently moved to the "on" position. Switch levers shall have automatic spring return to the "off" position.

ii. All pushbutton controls shall be of the momentary contact type, which make contact only while the button is depressed.

iii. Wherever possible, controls shall be arranged so that the movement of each controller handle shall be in the same relative direction as the resultant movements of the load. Pushbuttons shall be oriented in the same relative direction with respect to each other as the resultant movements of the load.

d) Limit Switches

i. Limit switches shall be provided for all cranes (including monorail hoists) as follows:

- Hoist-driven limit switches for the upper and lower hook position.
- A back-up over travel limit switch for the extreme upper position of each hoist; and
- Lever-operated limit switches for both end positions of all travel motions.

ii. Hoist-driven limit switches shall be totally enclosed and shall be of the traveling nut or rotating cam type, adjustable for circuit opening or circuit closing and adjustable for operation at any hoist position.

iii. **Back-up over travel limit switches** shall be of the block-operated type, where the trip action is caused by the lower sheave block. These limit switches shall be arranged and adjusted so that they trip only after the normal hoist-driven switch position is over traveled. Back-up limit switches shall be of the power type which directly interrupts the power supply to the hoist motor.

iv. All limit switches shall be of the type which resets automatically. Limit switches shall be of quick-break type, capable of stopping the equipment quickly under all conditions of speed and loading. All limit switches shall be unidirectional and shall not interfere with the motion in the opposite direction. Contacts shall be enclosed and protected from dust, moisture, and mechanical injury and shall be easily removable for replacement.

22.3.7 ELECTRICAL CONTROLS AND PROTECTION FOR OPERATION OF CRANES

22.3.7.1 General

a) The Power House Cranes shall be designed for operation from operator's cabin. The GIS Hall crane and Butterfly valve crane shall be designed for operation from Pendant Control System.

b) All crane motions (hoist, trolley, and bridge) shall be regulated by adjusting either the voltage and / or frequency of the electrical supply motor with a variable frequency drive device.

c) Each crane shall be provided with control panel / desk located in the operator's cabin. The controls shall provide for :

i. Individual independent control of cranes for all motions and various speeds up to normal speeds.

ii. Tandem operation of the two (2) cranes of power house when coupled electrically and mechanically for lifting heavier equipment weighing more than 150 tonnes.

22.3.7.2 Control Levers and Push Buttons

a) For individual independent control (start, stop and motor speed selection) of each crane, suitable joysticks/control levers/push buttons shall be provided as described in above.

b) The controls shall provide for torque and precise speed control of the various motors in adequate numbers of steps (within the range of stepless speed control) in both direction of motions.

22.3.7.3 Tandem Operation of Power House Crane

a) Master control equipment shall be arranged in such a manner so as to provide convenience and full view of the operator in the operator's cabin of each crane to enable tandem operation of the cranes from either of the two cabins or by a single radio control operator. In this operation one crane shall act as the master and the other shall act as the slave, for all the drives / motions and this duty shall be interchangeable.

b) Speeds of the various motions at all steps for both the cranes shall be identical and accordingly the ratings and characteristics of the corresponding motors shall be same.

c) Controls for changes in the speeds of the hoisting motor in the lowering direction shall be under the direct control of the operator and shall enable him to stop the motor without time delay from any position of the master switch.

22.3.7.4 Pendant Control System

a) General

GIS Hall and Butterfly valve house cranes shall be controlled / operated by Pendant control from their respective floors.

b) Pendant Control

The pendant control for there cranes shall have pendant control switches of pressed push button type which shall return to "OFF" position instantly on release. The pendant shall have one push button of lockable type for "OFF" function to enable cutting "OFF" the control power supply positively when the crane is not in use. The control push button station (pendant control) shall be suspended from the crane bridge on an electrical or spring type actuated cable drum, which permits the extension of the cable to allow the control from floors of the cavern. The pendant push button control station shall be freely movable along the entire crane bridge.

22.3.7.5 Operation of Brakes

Whenever power supply to the various drive motors for various motions is cut-off, the brakes shall be automatically and instantly applied. The brakes shall also be applied immediately in case of any over speed of the hoist motor in the lowering direction.

22.3.7.6 Electrical Interlocks

a) The main circuit breaker (CB) for power supply to the crane shall have interlock providing CB to be able to be closed only when all the control lever switches for the various motors are in "Off" positions. The interlock shall be so arranged that if the contactors for various motors / drives have failed to open even through the control lever switches have been brought to the "Off" positions, the CB will not close.

b) The master controller shall be provided with a thumb operated auxiliary switch so as to ensure the safety of personnel and equipment in case of loss of attention or chance death of the operator during operation of any crane. The control circuit of the master controller shall be so arranged that all the controls during starting and subsequent operations shall be de-energised unless the thumb operated switch is kept in pressed position. During the operation also if the operator fails to keep it pressed, the power supply to the controls shall be disconnected.

c) The inter locking arrangement shall be such that during tandem operation of power house cranes, if the main circuit breaker of one crane trips, the circuit breaker of other crane shall also trip automatically.

d) An isolator fitted on the crane bridge which cannot be operated from the floor, shall be provided to prevent inadvertent operation of the crane from the floor from Radio Remote Control system while maintenance work is being carried out on the crane.

e) Power supply to the cranes shall be provided by the owner. Tripple Pole isolators with indicating lamps shall be provided by the contractor at these locations so that it can be operated from ground and power supply can be cut off immediately in case of any emergency condition.

22.3.7.7 Miscellaneous Features

The controls shall have following provisions :

a) 3 pole 415 V AC, ACB with rupture current not less than 40 KA.

b) A master push button for complete emergency stop in the cabin at a convenient location.

c) A key operated electrical switch for the control circuit to prevent unauthorized operation and for the safety of maintenance and operating personnel.

d) Indicating lamp to show that the control circuit is healthy.

e) Indicating lamp for the main circuit breaker position (OFF or ON).

f) Radio Remote Control system with proper indication.

g) All control panels shall be of minimum 14 SWG, CRCA sheet steel.

22.3.7.8 Automatic Electrical Protection

The electrical equipment and circuitry shall be provided with automatic protection, as detailed below against various faults and mal-operation of the equipment.

a) Protective relays for protection against instantaneous over-current, over-load, single phasing and under voltage for all motors. The OC relay shall be adjustable between two (2) to three (3) times the full load motor current.

b) Protective relays of motors to trip the main power supply circuit breaker in case of their operation due to fault.

c) MCCB's for control and protection of all motor circuits.

d) Air circuit breaker located in operator cabin, of 3 pole, 415 V, A.C, totally enclosed type for power supply tapping from the main collectors, with interrupting capacity not less than 40 KA, equipped with short circuit, overload and under-voltage trip devices and one shunt trip coil and prevention against single phasing, three (3), timer relays and other necessary devices / items.

e) Protection against over speed of the hoist motors which shall cut-off the power supply and apply the brakes in case any hoist motor speed increases to 105% of the rated synchronous speed.

f) Operation of any protective relays of motors shall trip the motor supply circuits by opening the primary contactors of the motors.

22.3.7.9 Control Gear Accessories

a) Motors

i. Controls for various motors shall be frequency controlled acceleration devices.

ii. The motor - speed changes shall be provided by frequency convertor for all cranes ie. Power House, B.F. Valve House and GIS Hall Crane.

b) Joysticks

For the controls of the crane motors from the operators cage, suitable "Joysticks" shall be provided on the crane control desk.

c) Circuit Breaker / Controllers.

Each main supply circuit breaker or contactor shall have an interrupting capacity of not less than 40,000 amperes symmetrical at 415 volts. All switches, contactors, primary relays and primary circuits on the controller shall have a thermal capacity corresponding to 40,000 amperes for one second without injury and shall have a rating of atleast 660 volts and capacity ratings in accordance with the British Standards or those of the National Electrical Manufacturer's Association (NEMA) standards. Allowable temperature rises shall be as prescribed in the Indian Standards or other equivalent standard and based on an ambient temperature of 35^{o} C.

d) All switchgear control and protective equipment viz breakers, contactors, controller control switch, HRC fuses, relays, meters etc. shall be housed suitably in a cabinet placed in a manner convenient for operation and maintenance in the cabins / travelling girders of the cranes for wiring suitable terminal blocks complete and ready for making external connection shall be provided. The cabinet shall be tropicalized.

22.3.7.10 Alarm Gong.

An electrically operated alarm gong or buzzer which will sound while the crane is in motion shall be furnished with each crane. The alarm gong shall also be operable from a conveniently located switch when the crane is not in motion.

22.3.8 POWER SUPPLY TAPPING & OTHER ELECTRICAL ARRANGEMENT

22.3.8.1 Collectors

The collectors shall be designed to reduce sparking between collectors and conductors to the minimum. The minimum clearance between live parts and ground parts shall be 80 mm. The collector shall be suitably covered to avoid accidental contacts.

22.3.8.2 Trolley Conductors

The trolley conductors shall be of PVC/TRS flexible trailing cable type of copper core and of suitable size. It shall be mounted on retracing support.

22.3.8.3 Down Shop Leads (Main Runway Conductors)

a) A safe, robust and compact approved down shop leads (DSL) power supply system with suitable collector using latest technology shall be provided for the Power House, B.F. Valve House and GIS Hall. The location of these conductor are shown on respective specification drawings. It shall consists of substantial rolled copper conductors ~~or angle iron of adequate capacity with end brackets and insulators~~, straining bolts, intermediate brackets and insulators etc. to suit various caverns / underground buildings. One end of each conductor shall be fitted with a terminal log to enable power and earth wires to be connected. Safety guards shall be provided to avoid the possibility of any accidental touch with these conductors.

b) Down shop lead conductor system shall have ratings and characteristics as follows:

- Normal operating voltage, V 415
- Maximum design voltage, V 600
- Number of poles 3

Theses conductors shall have a continuous current rating as necessary to supply the maximum demand during crane operation, as determined by the greater of the following two (2) operating conditions:

- Load current for the simultaneous operation of main hoist motors and all bridge travel motors and
- Load current for the simultaneous operation of main hoist motors and all trolley travel motors.

c) The Down shop lead system, when assembled in place, shall permit independent longitudinal movement of the housings and conductors to allow for unequal thermal expansion and contraction. All conductors wherever required shall be housed in a common enclosure made of sheet steel not less than 16 gauge thick. Conductors shall be capable of carrying the rated current per pole continuously without overheating. Pickup trolleys shall have wheels equipped with sealed ball bearings and contacts of sufficient size to maintain full

current carrying capacity without overheating. Contacts shall maintain constant contact pressure and alignment with the conductors.

c) The supplier shall furnish all necessary supports, wall brackets, mounting bolts and accessories, anchor bolts, concrete inserts, and conduit and cable connections for the power supply to the feed box. The supplier shall verify and satisfy himself about the adequacy of levelling, grouting etc.

22.3.8.4 Power Conductors for the Crane Trolley and Monorail Hoist

Trolley power conductors shall be of the festooned (looped) insulated wire type. Each motor on the trolley shall have separate conductors for the power and control circuits, and in no case shall a power conductor be used as a common conductor for more than one circuit. The power conductors shall be insulated, jacketed, 90^0C conductor temperature, extra flexible cables. All conductors, insulators, and brackets shall be supplied with each crane.

22.3.8.5 Circuit Arrangement

a) The leads from the down shop collector shall be connected to a master manual magnetic contactor which shall be controlled by "on" and "off" pushbuttons and / or radio-controlled relays as specified for each crane. A control transformer shall be provided to activate the contactor and the radio receiver. The master contactor shall be connected to two (2) circuit breakers, each of appropriate carrying and interrupting capacity. One circuit breaker shall be connected to a 415 V/ 220 V, 3-phase, dry-type transformer of the rating required to supply power for all lights, controls, heaters, and convenience outlets on the crane. The second circuit breaker shall supply the main feed for the bridge, trolley, and hoist motors.

b) A 220 V, distribution panel equipped with branch circuit breakers as required, shall be provided to distribute power to the lights, heaters, and receptacles.

c) Interlocking circuits shall permit closure of the contactor only when all motion controllers are in the "off" position. Other interlocking features, as specified for the individual cranes, shall also be furnished.

22.3.8.6 Wiring

All electrical wiring shall conform to latest version of IS : 1554 (part I) "PVC insulated (heavy duty) electric cables, for working voltage upto and including 1100 volts". All conductors for primary power, lighting and control circuits shall be insulated for not less

than 1100 volts and shall have standard moisture resisting double braid coverings. All conductors between the secondaries of the motor contactors and resistors shall have sufficient current carrying capacity in accordance with the standard specifications and shall be insulated with 1100 volts class asbestos, high temperature type tropical insulation with moisture resisting impregnation. The primary conductors to the motor shall have standard, continuous current carrying capacity of not less than 100% of the rated full load primary current of the motors. All control and lighting conductors shall be of copper of suitable sizes. All the wiring shall be subject to approval of the purchaser. All wiring shall be laid in hot dip galvanised metal conduits. Alternately armoured cables can be used. Conductor having nominal equivalent copper area of cross section less than 2.5 mm shall not be used for wiring.

22.3.8.7 Illumination and Convenience Outlets

The permanent AC illumination system on the crane shall consist of four 1000 watts high bay beamed flood lighting units for the Power House, and two 1000 watts high bay beamed flood lighting units each for BF Valve House and GIS Hall to illuminate uniformly the area under each crane. Two 100 watts lighting units and two convenience outlets shall be provided in operator's cabin. A convenient outlet at each end of the bridge shall also be provided. The system shall be supplied from 415 V. AC crane power system through 415 V circuit breaker. For lighting and convenience outlets, 4 branch circuits shall be taken; one connected to two 100 watts lights in the operator's cage, another two branch circuits each connected to two 1000 watts high bay lights and fourth branch circuit connected to four convenience outlets. The wiring shall be done in accordance with latest Indian Electricity Rules. The 415 V circuit breaker shall be provided with an overload tripping element for each pole. The flood lighting units shall be suitable for control by both on-off push-buttons and radio control.

A portable hand lamp with plug and 25 m long wiring shall also be supplied for each of the crane by the supplier for use during maintenance.

22.3.8.8 Earthing

a) The crane structure, motor frames and metal cases of all electrical equipment including metal conduits or cable armoring or guards shall be efficiently bounded to facilitate earthing as per Indian Electricity Rules 1956 and latest edition of IS : 3043.

b) The supplier shall provide an earthing system to which all equipment under his scope of supply shall be interconnected. This system will in turn be connected by the purchaser to the power house earth mat to be laid by the purchaser.

22.3.9 RUNWAY RAILS AND OTHER MISCELLANEOUS ITEMS

22.3.9.1 Runway Rails for Power House, BF Valve House & GIS Hall Cranes

a) One (1) set each of runway rails suitable for each set of cranes complete with sole plates, anchor bolts, clamps etc. for the bridge travel shall be designed and supplied by the supplier. The rails shall extend for the :

i. Power House
ii. Butterfly Valve House.
iii. GIS Hall

b) The runway rails for Power House and B.F. Valve House cranes shall preferably be CR-100 type, as per IS: 3443. However, for smaller capacity crane of GIS Hall the rail section shall be selected to suit the crane and the load to be handled. The faces of the rail lengths shall be inclined at an angle of forty five (45^0) degrees to the length to provide oblique gaps between rail lengths.

c) The rails for bridge travel shall be laid on and fixed to the crane beam by means of anchor bolts etc. The supplier shall supply all the materials including embedded parts for fixing the bridge rails on the crane beam. The supervision of erection of embedded parts for crane rails shall be responsibility of the cranes supplier.

22.3.9.2 Towing Equipment for Power House Crane

Provision shall be made on each crane so that either crane when loaded may be pushed or towed, if required, by the other. The coupling arrangement shall be adequate for this purpose and easy to operate.

22.3.9.3 Anti-collision Devices for Power House Cranes

a) Provision of suitable anti-collision devices to prevent the collision of the two power house cranes shall be made.

b) The anti-collision devices which may be of mechanical actuator-limit switch type or any other suitable type shall be installed on the cranes. Details of device shall be furnished.

22.3.9.4 End Stops

Suitable end stops shall be provided at the end of the runway-rails for each set of the cranes.

22.4 INSPECTION AND TESTING

22.4.1 Shop Tests

22.4.1.1 The shop tests shall be carried on individual equipment/system as per relevant standards.

22.4.1.2 The bidder shall prepare for purchaser approval a detailed test programme for all shop tests. The shop tests shall be witnessed by the purchaser and consultant's personnel. Test certificates for all bought out items shall be furnished.

22.4.2 Site Tests

22.4.2.1 After installation at site and after finishing all works, the manufacturer shall carried out site tests as prevalent practices and relevant standards. Load for testing shall be arranged by the supplier at shop and site.

22.4.2.2 100 % Radiographic test on welded joint

100 % radiographic test shall be performed on all welding joints as per relevant standards and practices.

22.4.3 Final Acceptance Tests

22.4.3.1 After commissioning tests have been satisfactorily completed, the manufacturer, in cooperation with and under the supervision of purchaser shall conduct the final acceptance tests to determine whether all the manufacturer's guarantees and requirements of these specifications have been fulfilled:

22.5 INSTALLATION, OPERATION AND MAINTENANCE MANUALS

The manufacturer shall prepare manuals covering the information and the instructions pertaining to the following sections for

guidance during installation of the work and subsequently for guidance of the plant operating and maintenance staff :

Handling
Erection
Site Testing
Operation & Maintenance

The manuals shall be prepared and submitted as per the provisions detailed in the General Technical Specifications.

22.6 TOOLS, TACKLES AND SLINGS FOR ERECTION, TESTING & COMMISSIONING

The supplier shall provide/arrange testing instruments, tools, tackles and slings required for erection, testing and commissioning of the equipment at site. The list of testing instruments, tools, tackles & slings required to be arranged by the supplier shall be submitted along with the bid.

22.7 DEVIATIONS FROM SPECIFICATIONS

All the deviations from the specifications shall be separately listed in specified Annexure in the absence of which it will be presumed that the provisions of the specifications have been fully complied with by the bidder.

22.8 COMPLETENESS OF THE CONTRACT

Any fittings, accessories or apparatus which may not have been specifically mentioned in these specifications but which are usually necessary in the equipment shall be deemed to be included in the contract and shall be supplied by the supplier without extra charges. All plants and equipments shall be complete in all respects even if the details regarding all the items are not mentioned in these specifications.

22.9 DEPUTATION OF ENGINEERS FOR WITNESSING THE TESTS, INSPECTION AND TRAINING

The supplier shall arrange the inspection and inspection and training of engineers free of cost. Expenses related to traveling, lodging, and local transportation and daily allowance of purchaser's engineers should be borne by the purchaser.

22.10 SPARES

The tenderer shall include and quote for essential spares sufficient for first 5 years of normal operation for cranes in their tender listing items, their particulars, make, unit rates, total prices etc. List of Mandatory spares identified is given at Annexure-II. The tenderer shall review this list and recommend any modification, detection or addition with reasons theretofore, the spare parts shall be interchangeable with and shall be of the same or better quality than the original component. The spares shall be delivered with first crane and shall be packed for long storage periods.

22.11 GUARANTEED TECHNICAL PARTICULARS

The Bidder shall submit guaranteed & technical particulars of the equipment as per the format enclosed**.**

22.12 QUALITY CONTROL & ASSURANCE

The supplier has to supply cranes of best quality. The Supplier has to maintain quality control and assurance during the manufacturing of equipment as per approved owner's quality assurance plans.

SECTION-1

GENERAL TECHNICAL REQUIREMENT

1.0 GENERAL

1.1 This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical specifications and requirements brought out in the bidding documents.

1.2 The scope covers to meet technical requirements for the design, engineering, manufacture, testing at manufacturer's works before dispatch, supply and services for insurance, transportation, delivery at project site, handling, storage and preservation at store/site, transport to the place of installation, complete work of site assembly, erection, testing at site and commissioning, assistance in operation & maintenance, handing over & remedial action, if any, upto defect liability period for electro-mechanical works as specified in various sections on EPC basis.

1.3 Any equipment, even though not covered in the specification in various sections but required for successful operation of the plant, shall be deemed to be covered in the scope of supply.

1.4 The contractor shall be responsible for complete engineering of the plant and prepare layout drawings of the underground power house, transformer cavern, GIS floor, cable tunnel, outdoor pothead yard, schematics, piping drawings, cable schedule, cable routing drawings, interconnection drawings etc. and submit the same for the approval of purchaser.

1.5 The parameters of the equipment specified are indicative only. The contractor shall prepare design memorandum containing the main parameters of all the equipment selected by him, Design Calculation, the safety factors adopted, the material used for fabrication of components in line with the latest design practice and the safety measures adopted against flooding and fire in the underground station. The contractor will submit this memorandum for purchaser’s approval.

1.6 The contractor shall carry out studies wherever considered necessary to determine optimum parameter of the equipment such as high voltage withstand levels, short circuit withstand levels, Short-Circuit Calculations**,** Insulation co-ordination Studies**,** Voltage Drop Calculations**,** Earthing Network Calculations**,** Generator Earthing System Calculation**,** Selection of LV Breakers and Minimum Cable Cross Sections and to ensure successful synchronisation of the plant with 400 kV system and its commercial operation.

3.0 COMPLETENESS OF FACILITIES

3.1 Bidders may note that this is a EPC turnkey contract. Each component of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure a completely engineered plant shall be provided.

3.2 All equipments furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation of the equipment and for the safety of the operating personal, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

3.3 All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.

4.0 CODES & STANDARDS

4.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this contract shall comply with all currently applicable statutory regulations and safety codes of the Republic of India.

4.2 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish the complete word to word translation of the standard that is normally not published in English.

4.4 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

4.5 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.

4.6 Material Standards

ASTM (American Society for Testing Materials), AISI (American Iron and Steel Institute) DIN (German Industrial Standards) and BSI (British Standards) are approved standards for the supply of materials.

Material tests according to DIN 50049-3.1 C shall be provided for all important parts of the equipment such as: steel plates for parts under hydraulic pressure, all major castings (runner, shut-off valve, etc.), large forgings (turbine and generator shaft etc.), high stressed large bolts etc.

For less important parts, certificates according to DIN 50049-2.3 are acceptable.

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and the classifications and grades in conformance with the latest issue of the respective ASTM, AISI, DIN or BS standard. Material to other standards may be used if approval by the Owner has been obtained. Material specifications, including grade or class data, shall be shown on the appropriate detail drawings submitted for review.

The Contractor shall indicate in the Technical Data Schedules, the materials and applicable standards for all major parts of the supply.

The materials shall be carefully selected for the intended purpose and due consideration of the site conditions and the tropical environment. Higher grade material shall be used where ordinary material is insufficient.

"Not withstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

4.7 Units of Measurements

The international SI-system of units shall be used for documents, calculations, correspondence, drawings, etc., relevant to the Tender and the subsequent Contract.

5.0 EQUIPMENT FUNCTIONAL GUARANTEE

5.1 The functional guarantees of the equipment under the scope of the Contract are given in the Technical Specifications. These guarantees shall supplement the general functional guarantee provisions covered under Defect liabilities given in General Conditions of Contract.

5.2 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.

6.0 DESIGN FACILITIES

6.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

6.2 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR

7.1 Bidders may note that this is a EPC turnkey contract. Each of the project component and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely engineered plant shall be provided in respect of mechanical, electrical and power systems, control & instrumentation as per the scope defined in various

sections of the Technical-Specifications.

7.2 The Contractor shall furnish engineering data in accordance with the schedule of information as specified in Technical Data Schedules and Technical Specification.

7.3 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in **Annexure-I** to Technical Data Schedules.

7.4 **Engineering Information Submission Schedule**

7.4.1 Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information along with the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

i) Information that shall be submitted for the approval to the Employer before proceeding further, and

ii) Information that would be submitted for Employer's information only.

7.4.2 The Engineering Information Schedule shall be updated month wise.

7.4.3 The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The timely submission of drawings and data is as important to manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress. The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under specifications. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be construed by the Contractor, as limiting any of his responsibilities and liabilities for mistakes.

7.4.4 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Documents and the entire works covered under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Engineer in writing.

7.4.5 The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following:

7.5 **Basic Engineering Documentation**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Project Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

i) System description of all the mechanical, electrical, control & instrumentation.

ii) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

iii) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

iv) Operation Philosophy and the control philosophy of the Main Plant and other plants.

v) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.

vi) Basic layouts and cross sections of the main plant building (various floor elevations) and other areas including interface-areas included in the scope of the bidder.

vii) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

viii) The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Project Definition Manual (PDMs), which shall then be mutually discussed & finalised with the Employer.

7.6 **Detailed Engineering Documents** (AS APPLICABLE)

7.6.1 The contractor shall submit to the purchaser the following drawings/documents after the award of contract expeditiously in a sequential manner. Drawings shall be submitted in AUTOCAD format and the documents shall be submitted in PDF format. The bidder shall indicate separately the time schedule for submission of drawings for all the equipment covered in different sections for the approval of Purchaser, keeping in view the overall commissioning schedule of the project**.**

i) General layout plan of the station.

ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the project.

iii) Flow diagrams, Process & Instrumentation Diagrams

iv) Piping composite layout drawings.

v) Purchase specifications/ technical data sheets for all bought out and manufactured items.

vi) Detailed design calculations for components, system, equipments etc., wherever applicable including sizing calculations for all auxiliaries.

vii) Transient & hydraulic analysis of the project components and system wherever applicable.

viii) Comprehensive list of all terminal points which interface with Employer's facilities giving details of location, end connection details, forces, moments etc.

ix) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

x) Protection system diagrams and relay settings.

xi) Cables schedules and interconnection diagrams.

xii) Cable routing plan.

xiii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xiv) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xv) Sequence and protection interlock schemes.

xvi) Type test reports, insulation co-ordination study report and power system stability study report.

xvii) Control system configuration diagrams and card circuit diagrams and maintenance details.

xviii) Detailed software manuals & source software listing.

xix) Detailed flow chart for digital control system.

xx) Mimic diagram layout.

xxi) Model study reports wherever applicable.

xxii) Functional & guarantee test procedures and test reports.

xxiii) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

xxiv) For equipment foundation, separate composite general arrangement drawings for equipment foundation shall be furnished by the bidder including the location of pockets/bolts/inserts/embedments/pedestals and extent of grouting, point of application of loads etc.

xxv) Instruction Manual as per Clause No. 7.9.

7.6.2 The Contractor's while submitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

7.7 **Engineering Drawings**

7.7.1 All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I of the Technical Data Schedule. The soft copies to be supplied shall be either in CDs, DVD or through direct transfer via E-mail, etc. The drawings submitted for approval could be in the image form.

7.7.2 All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, weight of each component, for packing and shipment, the external-connection fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

7.7.3 Each drawing submitted by the Contractor (including those of sub-vendors) shall bear a little block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number and the name of the Project, drawing number and revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawings shall be in English. All the dimensions should be in metric units.

7.7.4 The drawings submitted by the Contractor (or their sub vendor's) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

7.7.5 The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings / documents / calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

7.7.6 Similarly, all the drawings / documents submitted by the Contractor during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.

7.7.7 The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the

project. The review of these documents / data / drawings by the Employer will cover only general conformance of the data / drawings / documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and / or approval by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

7.7.8 After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer. Also soft copies of Approved drawings shall be supplied by contractor either in DVDs or Hard drives.

7.7.9 All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment / system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipments / system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specifications.

7.8 **As Built Drawings**

7.8.1 After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to "as built" conditions.

7.8.2 Drawing must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings / documents for the same.

7.8.3 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the contract documents and the entire works covered

under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Engineer-in-charge in writing.

7.9 Instruction Manuals

7.9.1 The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project and shall be submitted during detailed Design Stage. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in **Annexure-I**. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

7.9.2 Erection Manuals

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

i) Erection strategy.

ii) Sequence of erection.

iii) Erection instructions.

iv) Critical checks and permissible deviation/tolerances.

v) List of tool, tackles, heavy equipments like cranes, dozers, etc.

vi) Bill of Materials

vii) Procedure for erection.

viii) Procedure for initial checking after erection.

ix) Procedure for testing and acceptance norms.

x) Procedure / Check list for pre-commissioning activities.

xi) Procedure / Check list for commissioning of the system.

xii) Safety precautions to be followed in electrical supply distribution during erection

7.9.3 Operation & Maintenance Manuals

7.9.3.1 The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Employer to operate, maintain, dismantle, reassemble and adjust all parts of

the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment including, operation, maintenance, dismantling and repair. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Employer.

7.9.3.2 If after the commissioning and initial operation of the plant, the manuals require any modification/ additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Employer for records.

7.9.3.3 A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.

7.9.3.4 The manuals shall include the following

i) List of spare parts along with their drawing and catalogues and procedurefor ordering spares.

ii) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

iii) Where applicable, fault location charts shall be included to facilitate finding the cause of maloperation or break down.

iv) Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. required for the complete plant.

v) On completion of erection, a complete list of bearings/equipment giving their location, and identification marks etc. shall also be furnished to the Employer.

8.0 Monthly Engineering Progress Report

8.1 During the period of contract, the Contractor shall, before the tenth (10th) day of each calendar month, submit monthly progress reports in a format acceptable to the Purchaser, detailing the progress of the work during the preceding month. The report shall contain but are not be limited to the following information:

i) A general description of the Works performed during the reporting period on each main activity and include any notable problems which were encountered.

ii) The total overall percentages of erection works completed, with reference to the CPM programme. Appropriate comments shall explain differences if any.

iii) The percentages of each main work activity completed during the reported month with reference versus the scheduled programme. Appropriate comments shall explain differences if any.

iv) A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain differences if any.

v) A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and / or completion dates are different from those shown on the CPM programme, an explanation shall be given.

vi) A list of local manpower (by trade classification) employed during the reporting period.

vii) A list of expatriate personnel (by position) employed during the reporting period.

viii) A list of the Contractor's Equipment and materials presently located at the Site. Also a list of equipment and materials, which arrived at the Port of arrival and is in the process of being cleared through customs.

ix) Progress photographs of significant events. The Purchaser may direct the inclusion of specific photographs if deemed necessary.

x) Main items of temporary facilities constructed during the reporting period.

xi) A statement detailing the status of progress on the overall programme and how to regain any lost time or set-backs which may have occurred.

xii) A list of inoperable temporary equipment, and the estimated date when the repair will be completed.

xiii) A statement concerning potential problems and recommendations on how they could be resolved.

xiv) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

xv) Drawings which were not submitted as per agreed schedule.

8.2 The draft format for this report shall be furnished to the Employer after award of the contract, which shall then be discussed and finalised with the Employer.

x) Performance guarantees test

xi) Removal of erection equipment and clearing of Site

xii) Interdependence with work of other contractors.

9.3 The Contractor shall pay particular attention to the dates established for the submission of "installation and foundation" drawings with loading data, anchoring details, recesses, block-outs etc., and all information necessary for the preparation of the civil work design drawings.

9.4 Since the Schedule dates are dependent on the progress of other contracts, the Contractor shall suitably co-ordinate his operations at the Site with those of other contractors.

10 Painting and Surface Treatment

10.1 Scope

All the equipment furnished and installed by the Contractor shall be completely painted for final use, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and number of coats approved by the Owner. The Contractor shall perform all painting work in the shop, before shipment, followed by a field touch-up during or after installation. If accepted by the Owner, the Contractor may apply the last coat of paint at the site instead of applying it in the shop.

10.2 Standard Products

All materials, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers, and shall be subject to Owner's review for acceptance.

10.3 Colour Schedule

	Colour	Standard Ref.
• Raw water pumps	Mint green	RAL 6029
• Raw water strainers	Mint green	RAL 6029
• Heat exchangers	Mint green	RAL 6029
• Turbines	Silicon gray	RAL 7032
• Governors	Silicon gray	RAL 7032
• Oil pressure piping	Yellow orange	RAL 2000
• Oil purification system	RAL 2000	Yellow orange
• Lubrication oil piping	Yellow orange	RAL 2000
• Air compressors	Sky blue	RAL 5015

• Air piping	Light blue	RAL 5012
• Tops of generators	To be decided at a later date.	
• Transformers	- do -	
• Switchyard equipment	- do -	
• Enclosures for electrical power equipment	Melon yellow	RAL 1028
• Enclosures for electrical control and protection equipment	Pearl white	RAL 1013

11.0 Fluids and lubricants

11.1 General

The Contractor shall deliver to the Owner all equipment complete with initial fill of fluids, grease or lubricants, transformer oil, and replace any quantity used up or lost during installation and testing.

11.2 Compatibility

The oil used for the lubrication and oil pressure systems for the turbine, governor, and generator shall be ensured to be of the same type. In case of any deviation, approval of the owner shall have to be obtained by giving full justification as the above can not be allowed in normal case.

The Contractor shall coordinate with the owner, the type of fluids and lubricants used in the bearings.

Upon completion of the design, the Contractor shall furnish a tabulation confirming the quantities and types of fluids and lubricants required for initial application for each item of equipment.

11.3 Supply

The Contractor shall furnish the following:

- All oil for initial filling of all equipment supplied, plus 10% additional.
- Grease if required for initial filling of all of the equipment, plus 10% additional.
- Flushing fluids to flush and clean all systems.

11.4 Pipe Connections

External connections for all equipment shall be in accordance with the applicable standards.

Internal connections shall be in accordance with standards selected by the Contractor and accepted by the Owner.

Adequate pipe supports and mounting hardware shall be provided for all piping in the Contractor's supply.

12.0 Dimensional Checks and Visual Inspection

Dimensional checks shall be performed on all major parts, components and partial assemblies, especially when close tolerances and fits are involved (tolerance of shafts, between stationary and moving parts, connecting dimensions for the assembly with other supplies, etc.). If the dimensional checks show discrepancies in measurement which may affect the fit, assembly or dismantling of the respective part or component, the same have to be corrected correspondingly. Such correction or modification shall, however, in no way lead to sacrifices with respect to reliability of operation or inter-changeability, and shall be performed only after the agreement of the Owner has been obtained. If the correction or modification cannot be carried out in accordance with the terms mentioned above, the part or component concerned may be subject to rejection. Faulty machine parts or equipment shall by no means be delivered.

All major finished surfaces shall be subject to visual inspection in the presence of the Owner. Runner blades, stay vanes and wicket gate feather profiles shall be checked by means of templates which should be prepared/manufactured exactly as per drawing, as far as possible.

13.0 Functional Tests

Functional tests on partial assemblies and/or complete assemblies shall be carried out as much as possible already in the manufacturer's workshops. Such tests shall be performed as far as possible under operation-like conditions.

When requested by the Owner, the functional tests shall be repeated until full proof has been obtained that the functioning of the assemblies will comply with the requirements of the Contract Documents.

14.0 Embedded Parts and Anchor Bolts

All embedded anchor bolts, rods, welding plates and support plates shall be provided. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is embedded. The embedded end of the rod shall be provided with a steel plate which shall be welded to the rod and sleeve to provide anchorage and to prevent entry of concrete into the sleeve during installation. The threaded end of the rod shall be provided with two steel nuts and two steel washers to permit leveling and anchoring the equipment prior to grouting.

Approved types of expansion or chemical anchors shall be used where practicable for small equipment.

15.0 Electrical Equipment

15.1 General

The electrical equipment delivered under this contract shall be new and of high quality, suitable for the purpose it is intended for, free from defects and imperfections, and it shall be of the classifications listed herein, or their equivalents, subject to acceptance by the Owner.

The equipment shall meet the applicable IEC Recommendations, international standards such as ANSI - IEEE -DIN- SEN or others, that can be shown to be comparable to these. The IEC and IEEE recommendations for approval of equipment and tools are applicable.

The equipment design shall be suitable to render satisfactory operation under the conditions prevailing at the site, and the equipment shall operate satisfactorily under normal load and voltage variations. The design shall further include all necessary provisions ensuring the safety of the operating and maintenance personnel.

Each equipment assembly, or unit containing electrical devices and wiring, shall be completely wired in the shop. Wiring shall be neatly arranged and protected against mechanical damage, terminating in terminal blocks located in a connection box or cubicle, on or near the unit.

15.2 Auxiliary voltages

15.2.1 AC power

Three phase- system with grounded neutral for feeding three-phase and one phase consumers (connected between phase and neutral), type TN-C according to IEC Publication 364-3, 415/240 V □10%, 50 Hz □ 3%. Frequency variation under extreme condition may be □ 5%. All motors and other electrical apparatus should be designed to work continuously under □ 5% frequency variation and □ 10% voltage variation.

15.2.2 **DC power**

D.C. Systems, ungrounded, with earth fault detection

220V + 20% to -25% for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials load.

48V + 20% to -25% for the supply to EPABX etc.

Other voltage systems eventually needed, shall be generated from the above systems by means of dc/dc converters, inverters etc.

15.3 **Temperature rises**

The temperature rise for the major electrical components is cited in the respective chapters of these Contract Documents. Whenever no special mention of temperature rise is made, it shall be understood that the temperature rise is in accordance with the IEC Recommendations.

15.4 **System Parameter**

Nominal	Variation under worst condition
Voltage 400KV	360-440KV
Frequency 50Hz	47.5-52.5Hz

16.0 **Electrical Equipment Enclosures**

16.1 **General**

All electrical equipment, apparatus and devices shall be of suitable design for satisfactory operation under the conditions prevailing at the Site. The equipment shall operate satisfactorily under normal load and voltage variations in accordance with IEC Publications.

The design shall also include all necessary provisions ensuring the safety of the operating and maintenance personnel.

All electrical connections and contacts shall be of ample cross section and capacity for carrying continuously the specified currents without undue heating and shall be secured by bolts or set-screws of ample size, fitted with locknuts or lock washers of approved types.

Unless otherwise expressly stated, conductors and all other current carrying parts shall be electrolytic copper in accordance with approved, applicable standards.

Cubicles and other enclosures containing electrical equipment shall be especially treated to prevent corrosion. All cubicles shall be provided with a door switched lighting fixture and a single phase socket for power outlet.

All interior surfaces of electrical apparatus, enclosures etc. including contactors, relays, coils, etc., shall be treated in an approved manner to prevent mould growth. Such treatment shall in no way interfere with the proper operation of the equipment either electrically or mechanically.

Bigger assemblies such as switchboards, etc., shall be designed to present suitable transportation divisions adapted to the local conditions within the plant.

Unless otherwise specifically called for or described in these Contract Documents all electrical appliances shall conform to the applicable IEC Publications.

16.2 Construction requirements

All cubicles and enclosures shall be of good quality standard production subject to approval by the Owner. Cubicles shall be free floor standing type, of rigid frame covered with removable steel sheets. The frame shall be bolted to the floor. There shall be provision and enough space for entrance of cables from above or below as necessary. The cubicles shall be ventilated if needed; in this case removable filter inserts shall be fitted to the air entrance openings. Provision for cable fastening shall be inside the cubicles and enclosures, and sufficient space from cable fastenings to nearest terminal. All control and indicating instruments such as contactors, circuit breakers, auxiliary relays, indicating instruments, switches etc., shall be functionally displayed in appropriate location. All indicating devices shall be visible with the door closed. The layout is subject to the approval of the Owner.

If required, flush mounted hinged steel doors with latches shall be available: doors shall be with approved locks. The locks shall be of the same type throughout the plant. All panels and cubicles shall have a uniform appearance.

The cubicles and enclosures shall be of protection class IP 54 or higher according to their location, unless otherwise, there are constraints which may prevent to maintain above protection class and same shall be justified by the contractor and approval shall be taken from the owner for the deviation. All cubicles shall be equipped with automatically controlled heating elements for protection against internal condensation and moisture.

All panels/cubicles shall have approximately 20% space for mounting of future devices.

16.3 Wiring

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be stranded copper and shall be not smaller than 2.5 mm2, except as otherwise agreed by the Owner. Larger size wiring shall be used where needed for the current carrying capacity requirements.

Cables shall have at least 1100 V PVC insulation except for 220V DC and telemetering or communication system equipment for which 650V and 300V rating respectively are acceptable. .

For current and potential transformer secondary circuits the cross section of the conductors shall not be less than 6 mm2 and 4 mm2 respectively.

Wiring shall terminate at terminal blocks at one side only. Where tap connections are required they shall be made on terminal blocks. Wiring shall be neatly arranged and laid in conduits accessible from the front door. The conduits shall not be filled more than 70%.

Each cubicle shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

16.4 Terminal blocks

The terminal blocks shall be located to allow a neat and easy connection work and shall be safely accessible while the equipment is in service. Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks. Power terminal blocks shall be rated in accordance with applicable standards, and shall be provided with covers. Control wiring terminal shall be equipped with facilities for opening the circuit. It shall be possible to interchange a single terminal block for a new one without dismantling a whole row. Current transformer terminal blocks shall have provisions for short circuiting. Not more than two wires shall be connected to any

one terminal. Terminal blocks using screws acting directly on the wire will not be accepted. At least 20% spare terminals shall be provided. Terminals shall be marked with printed labels.

16.5 Grounding

The Contractor shall connect all equipment included in the scope of delivery to the grounding system of the Powerhouse, transformer substation and the switchyard. Two grounding mat i.e. power house grounding and transformer substation grounding shall be connected for effective grounding system. If necessary, third grounding mat shall be laid at T.R.T. outlet and shall be interconnected. In addition to the grounding through cable screens, all equipment such as cubicles, motors, etc. shall be connected directly to the grounding system using copper wire of area not less than 50 mm2 at two different points. In general all iron parts such as supports, covers, railing, etc. shall be connected to the grounding system. Each conductor shall have its own separate connection point. Pressed on closed shoes shall be used for connections to bars.

16.6 Protection devices

For short circuit and overload protection of lower rating power and control circuits, moulded case circuit breakers and MCBs respectively shall be used.

Outlets from AC (and DC) distribution panels are protected in their respective panels.

16.7 Marking of equipment and wiring

All internal equipment and wiring shall be neatly and clearly marked as indicated on the schematic and wiring diagrams. Internal wiring and cables shall be marked with sleeve type engraved marking. Marking system and marking material shall be subject to approval by Owner. Identification of the respective conductors shall be in accordance with the requirements of IEC publication 204. In cable having 5 conductors or more the individual conductors shall be numbered throughout the entire length. In cables having less than 5 conductors colour coding in accordance with IEC Recommendations 204 shall be used.

16.7.1 Colour Coding for Electrical Connections

Live parts of electrical connections shall be colour coded as follows:

Conductor Designation	Coding Alphanumeric	Symbol	Colour
A.C. network	phase 1	R	red
3 phase	phase 2	Y	yellow
	phase 3	B	blue
	neutral	N	black
A.C. single phase	phase	P	red
	neural	N	black
	earth	E	green-yellow
D.C. network	positive	a	red

negative	b	black

16.7.2 **Colour Coding for Mimic Diagrams**

Mimic diagrams to be arranged on switchgear cubicles, control panels/desks, etc., shall be colour coded as follows:

420 kV	Gold
13.8 KV	signal red
415 V	black
220 V D.C.	violet
48 V D.C.	white

Note: Colours given under 2.17.7.1 and 2.17.7.2 shall be finally agreed upon during detailed design.

16.8 **Compatibility**

Equipment serving similar or same purpose shall as far as possible be of same make and type. All indicating lights shall use same type of light bulbs.

17.0 **Cable Laying**

Wiring between equipment enclosures shall be made with cables, laid in trenches and/or cable trays and in cable conduits. The Contractor shall submit for review to the Owner a cable route layout showing location of trenches, conduits and trays. All material for cable laying such as cable trays supports and fastening material shall be furnished and placed by the Contractor. Cables shall be properly fastened and marked where they enter enclosures either by cable clamps or nipples. Cables in horizontal cable trays shall be fastened properly with clamps or plastic strips. Power and control cables shall be placed in separate trays or conduits. Cables shall be clearly marked at each terminal point.

18.0 **Control Concept**

The operations, control procedures, monitoring and protective devices for the plant are described in chapter of, Control and Monitoring system and protection system. The Contractor shall furnish all equipment required for effecting the intended method of operation and control, within the plant.

Primarily, control of equipment shall be automatic, but manual control and/or local control of the various components shall also be possible from control boards during operation, testing and maintenance of the respective components. Interlocking devices shall be incorporated in the control circuits in the quantity needed to guarantee correct sequence of operation of the equipment. Protective devices shall be supplied and the particular needs of equipment furnished with the aim of ensuring a safe and reliable operation of the plant in the event of electrical and mechanical disturbances or in case of mal-operation by the plant personnel.

In the design of the control systems for different parts of the plant the Contractor shall take care of standardizing the components used.

Where programmable logic controllers are used these shall to the extent possible be compatible. Where control systems are based on relays, sufficient information on the operating status shall be provided through potential free change-over contacts connected to outgoing terminals for comfortable connection.

19.0 Handling Devices

Lifting lugs, brackets, eyes, and other items required for attaching lifting devices shall be provided on all of the major components of the equipment weighing more than 25 kg. All slings and lifting devices required for attachment to the components and assemblies and to a crane hook for handling during erection and later disassembly shall be furnished.

20.0 Control Switches, Indicating Lamps and Instruments

20.1 General

Control switches, indicating lamps and instruments shall be arranged so that all parts are readily accessible for servicing without the necessity to remove other devices, terminal blocks or excessive amount of wiring.

All control switches and indicating devices mounted in cabinets and enclosures shall be visible with the doors closed.

Identification nameplates shall be provided for all control switches, indicating instruments and lamps, in accordance with clause 2.22, Nameplates.

Instruments and controls shall be located so that their dials, indicators and nameplates are clearly readable. Data for all instruments to be provided, including type, size, scale range, electrical ratings, nameplate and name of manufacturer, shall be furnished. Steel panels shall be provided for group mounting of the instruments. All instruments shall be of an approved type and shall match, insofar as practicable, the other instruments with which they are associated; their dial type, scaled markings and units, type of connection and mounting, shall be coordinated. All piping and tubing required for instruments shall be furnished and installed.

All instruments and control switches shall be furnished with necessary auxiliaries, i.e. resistors, shunts etc.

20.2 **Control switches**

The switches and push-buttons shall be provided with ample contact ratings, suitable cam or block arrangements necessary for the control functions on 415 V AC or 220 V DC circuits. The control switches used in mimic diagrams shall be of discrepancy type with built in lamp indication.

20.3 **Indicating and signalling lamps**

Each indicating and signalling lamp shall have a removable cap which can be inscribed with wording and shall not be affected with the heat of the lamp. Light bulbs shall be replaceable from the front of the panel. The indicating and signalling lamps shall be of the same size and type.

20.6 **Measuring Transformers**

Potential transformer secondary windings shall be rated 110/√3 V

Current transformer secondary windings shall have a rated current of 1A/ 5A.

21.0 **Nameplates**

Each major and auxiliary item of equipment shall have a nameplate permanently affixed thereto, or as directed, showing in a legible and durable manner the serial number, name and address of the manufacture, rated capacity, speed, electrical characteristics, and other significant information, as applicable. Nameplates of distributing agents only will not be acceptable. Nameplates shall also be provided for identification of all panels, cubicles and other enclosures as well as for panel-mounted devices, dials, gauges instruments and control devices. Nameplates shall be marked with the nomenclature and units of measurement used in the metric system (SI- units), and a schedule of such markings shall be submitted for review. Type of nameplates and wording on identification nameplates shall be submitted in English for approval. The Owner will translate the text if needed and the Contractor shall furnish and attach the nameplates.

21.1 **Cautionary signs**

English shall be used as prime language on nameplates required for caution or warning signs, identification plates for control devices, and instruction plates.

21.2 **Other nameplates**

Nameplates which are not required for the operation of the equipment and are not of a cautionary or warning nature required for the safety of personnel, i.e. showing motor speeds, horsepower, electrical characteristics, name and address of manufacturer and other information necessary for maintenance and repair work are to be in English.

22.0 **Equipment Service Conditions**

All equipments and material supplied under this contract shall be suitable for operation under the following service conditions

23.0 **Model, routine and type tests:**

23.1 Model Test shall be performed on Turbine as per clause 2.1.4.6 of the Technical Specifications. Prices quoted for Turbine shall, therefore, be inclusive of the cost of performing the model test.

23.2 Type Tests shall necessarily be performed on 17.5 KV Bus Duct and one of the 46 MVA single phase Step Up Transformers as per relevant IEC as stipulated in Chapter-4 and 5 of the Technical Specifications respectively. Prices quoted for these two items of equipment shall, therefore, be inclusive of the cost of performing these Type Tests.

24.0 Spare Parts and Tools

24.1 Spare Parts

24.1.1 All spare parts to be supplied shall be interchangeable with the corresponding parts of all the plant supplied under these Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components. Before issue of the Taking-Over Certificate the spare parts shall be checked and tested at the Site by the Contractor in presence of the Purchaser.

24.1.2 Acceptance of any spare parts will not take place before the Contractor has submitted the complete final detailed list of all spare parts and tools.

24.1.3 All spare parts shall be protected against corrosion and shall be marked with identification labels in the English Language. The identification shall be in accordance with the agreed Plant Identification System.

24.1.4 All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage. The Contractor shall label and conveniently store all

spare parts in racks provided by him in ready to use manner before handing over to the Purchaser.

24.2 Mandatory Spare Parts

24.2.1 At least the quantity of mandatory spare parts required for successful operation and maintenance of the plants and equipment for a period of 5 years shall be included in the Total Tender Price and consequently in the Scope of Works of the Contract.

24.3 Recommended Spare Parts

24.3.1 If any additional spare parts are recommended by the Contractor, these shall be stated in quantity and description in the Technical Data Sheets for each item.

24.3.2 Prices for additional recommended spare parts shall not be included in the Total Tender Price for evaluation purpose.

24.4 Mandatory Tools and Appliances

24.4.1 Contractors shall supply all mandatory tools & appliances as specified in technical specification. Contractor shall also suggest any addition and deletion in the list specified by the purchaser required for total assembly and disassembly of all parts of the supplied plant and accessories for maintenance of the plant.

24.5 **Recommended Special Tools and Equipments**

24.5.1 The Contractor shall have to furnish the list of recommended special tools and equipments. Prices for recommended special tools & equipments shall not be included in the total tender price.

24.5.2 Foreign bidder shall identify the indigenous source (within the country of operation of the unit) for supply of spares and indicate the same in their offer.

30 TRANSPORT AND INSTALLATION

30.1 The bidder is advised to have a total study of all aspects of transportation of equipments to site and should make schedule of transportation in accordance with the prevailing conditions at site. The bidder shall specifically understand that the Purchaser will do the general co-ordination of storage and erection works as well as civil engineering works of power house .An appropriate period for transportation shall be considered accordingly.

30.2 The Purchaser will do the general co-ordination of storage and erection work as well as the civil engineering work under the different packages on site.

30.3 The delivery dates, transportation and erection periods and for all other associated activities indicated in the Contract Documents shall be strictly adhered to. Changes, which are unavoidable or necessary, will be regulated in accordance with the stipulations laid down in the General Conditions of Contract.

30.4 From the time of manufacturing until commissioning all parts of the plant shall be protected and insured at the Contractor's expense against loss & damage of any kind. Parts, which are damaged during transport, storage, erection or trial operation, shall be replaced at the Contractor's expense.

30.5 Packing and Marking

30.5.1 The Contractor shall prepare all plant, devices and materials for shipment to protect them from damage in transit, and shall be responsible for and make good all damages due to improper preparations, loading or shipment.

30.5.2 After the workshop assembly and prior to dismantling for shipment to the Site, all items of machinery and plant shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so that are clearly visible.

30.5.3 Dismantling shall be done into convenient sections, so that the weights and sizes are suitable for transport to Site and for handling on the Site under the special conditions of the Project.

30.5.4 All individual pieces shall be marked with the correct designation shown on the Contractor's detailed drawings and other documents (packing, lists, spare part lists, in Operating and Maintenance Instructions, etc.).

30.5.5 Each piece, separately shipped, or smaller parts packed within the same case or box, shall be legibly, marked to show the unit to which it is a part and match-marked to show its relative position in the unit.

30.5.6 Unit marks and match-marks shall be done preferably by punching the marks into the metal before painting, galvanizing, etc., and shall be clearly legible after painting, galvanizing etc. In labelling, the Contractor shall endeavour to use as few designations as possible, and each part of identical size and detail shall have the same designation, regardless of its final position in the plant.

30.5.7 All parts of the plant shall be packed at the place of manufacture; the packing shall be suitable for shipment by sea and for all special requirements of the transportation to Site. Where necessary, double packing shall be used in order to prevent damage and corrosion during intermediate storage.

30.5.8 All identical members shall be packed together, if reasonably possible, in a form convenient for shipment and handling.

30.5.9 Small items shall be packed in boxes and large items shall be protected where necessary, by timber, straw and sacking. Drums shall be used for electric cables, steel ropes, steel wire and similar materials. All bolts, nuts, washers. etc., shall be packed in containers. Each container shall include only bolts, nuts or washers of identical size.

30.5.10 All parts shall be suitable protected against corrosion, water, sand, heat, atmospheric conditions, shocks, impact, vibrations, etc.

30.5.11 All electrical parts shall be carefully protected from damage by sand, moisture, heat or humid atmospheric conditions by packing them in high pressure polyethylene foil. Where parts may be affected by vibration, they shall be carefully protected and packed to ensure that no damage will occur while they are being transported and handled.

30.5.12 Spare parts shall be packed separately and designated as specified and shall be delivered properly and adequately

packed for several years' storage. All packing costs shall be included in the scope of Work.

30.6 Shipping Marks

The Contractor shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked on at least two sides as follows:

Consignee:

Contract No.:

Port of destination:

Item number (if applicable)
Package number, in sequence and quantity per package:

Description of Works:

Net and gross weight, volume, Dimensions

30.7 Packing Lists

The Contractor shall provide the Purchaser with one (1) original and two (2) copies of all shipping documents and relevant packing lists of each shipment of equipment items after the same has been shipped. One copy (1) of the packing list shall sent to the Purchaser's Representative. All packing lists shall contain the name of the Contractor or supplier and shall show the complete markings on each packed box or crate that has been shipped. Separate packing lists shall be prepared for each and all shipments made. One copy of the packing list shall be placed inside each box or crate, and one copy inserted in a weatherproof envelope affixed to the outside of each box or crate.

30.8 Equipment Handling and Storage

30.8.1 All equipment shall be handled very carefully to prevent any damage or loss. Wires, chains, ropes slings etc. used for handling of the equipments shall be appropriately protected by sleeves or other means to prevent damage to the equipment.

30.8.2 The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the storage shall be moved to the actual location at appropriate time so as to minimize risk of damage of such equipment at site.

30.8.3 The Contractor 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 Contractor is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc.

30.8.4 All large parts of the plant shall be brought, as far as possible and practicable, directly to their final place of erection.

30.9 Storage Area and Warehouses

30.9.1 The Purchaser will designate areas where the Contractor may store parts of the plant. The Contractor shall, at his own expense, render such areas suitable for the respective purposes.

30.9.2 The warehouses shall be weatherproof, with good ventilation and solid floors. The floors of the warehouses and storage areas shall be designed to carry the loads imposed on them by the stored parts. The following parts shall be stored inside enclosed warehouses:

i) Electrical parts with electrical devices attached, electric motors and excitation equipment

ii) Instruments, welding material and equipment, bolts, pins, packing, tools, insulation materials A

iii) All small parts and parts of the plant which already have been finally painted.

30.9.3 All electrical panels, control gears, motors and such other devices shall be properly dried by heating before they are put into storage. If panels equipped with anti-condensation heaters will be stored over longer period of time (more than one month), the Contractor shall assure that the heaters are energised.

30.9.4 Motor bearing slip-rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and motors shall be periodically rotated to prevent corrosion due to prolonged storage.

30.9.5 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 place from the moment of storage to the moment of installation.

30.9.6 All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the powerhouse shall be protected from weather or humidity.

30.9.7 The consumable and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage

30.9.8 The Contractor shall ensure that all the packing materials, and protection devices used for the equipment during transit and storage are removed before the equipment are installed. The packing materials and protection devices shall remain the property of the Purchaser and shall be handed over to him by the

Contractor after completion of the work. In case, the Contractor fails to return the packing materials and protection devices, the Purchaser shall have the discretion to deduct from the Contract price at a reasonable amount on this account.

30.9.9 If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the Purchaser will have the right to get it moved to the areas earmarked for the Contractor at the Contractor's cost.

30.9.10 The contractor shall maintain an accurate and exhaustive record that details out the list of all equipment received by him for the purpose of erection and keep such record open for inspection of the Purchaser at any time.

30.10 Preparation of Site Installation Works

30.10.1 Prior to commencement of installation, the Contractor shall closely inspect the Site and all the foundations and other structures on which parts of the plant supplied under this Contract will be installed; he shall check that the foundations conform to the installation drawings.

30.10.2 The result of this check shall be reported to the Purchaser in due time to allow any errors to be corrected before the commencement of erection. All parts of the plant shall be cleaned carefully of all contamination such as dust, sand, rust, mill scale and other dirt prior to installation.

30.11 Reference Points

30.11.1 The Purchaser will provide major centre lines and datum levels only. The Contractor shall be responsible for transferring those required to carry out the Works. The Contractor shall employ a competent surveyor for setting-out of all datum lines including the constant checking and maintenance of the setting-out until the completion of his works.

30.11.2 The Contractor shall provide all necessary pegs, profiled templates and centre lines and shall establish all such permanent markings and recovery marks as may be required by the Purchaser for checking the Contractor's setting-out. The Contractor shall be responsible for rectifying, at his own cost, all work rejected by the Purchaser due to errors in setting-out.

30.11.3 All bench marks, kerb marks, pegs and signals on the surface, alignment pins and the like put in by the Purchaser for the purpose of checking the Contractor's work or as permanent survey marks will be under the care of the Contractor during the period of the Contract. He shall, at his own expense, take all proper and reasonable care and precautions to preserve and maintain them in their true position where such marks are within or adjacent to his work area. In the event of their being disturbed or obliterated by any cause whatsoever, they may, if so determined by the Purchaser, be replaced by the Purchaser at the Contractor's expense.

30.11.4 The Contractor shall be responsible for the true and proper staking-out of the works and levels of reference given by the Purchaser in writing, for the correctness of the positions, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour in connection with this.

30.11.5 The checking of any staking-out or of any line or level by the Purchaser or the Purchaser's Representative shall not in any way relieve the Contractor of his responsibility for its correctness.

30.12 Installation Work

30.12.1 All transportation and handling of the plant from the place of storage to the place of installation shall be carried out by the Contractor. He shall also provide all hoisting equipment, staging and scaffolding, winches and wire ropes, slings, tackles and all other appliances and temporary materials. The erection staging and scaffolding shall be provided with coverings and barriers and shall guarantee safe working conditions.

30.12.2 The Contractor shall comply with all applicable and approved safety regulations while carrying out the works at Site and with all reasonable requirements of the Purchaser. This stipulation shall in no way release the Contractor from any obligation concerning his liability for accidents and damage. He shall be responsible for adequate protection of persons, plant and materials against injuries and damages resulting from his operations.

30.12.3 The plant or parts to be installed shall not be over-stressed during the process of installation.

30.12.4 The Contractor shall be responsible that the installation of all plants is properly executed to the correct lines and levels and in accordance with the manufacturer's instructions and the Contract requirements.

30.12.5 The alignment of the plant shall be done exactly; the tolerances indicated by the Manufacturers or in the drawings shall be kept.

30.12.6 Setting of parts to be aligned shall be performed by means of fine measuring instruments. All erection clearances and settings shall be given to the Purchaser. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc.

30.13 Embedded Parts

30.13.1 Anchor bolts, base plates, anchor rails, etc. to be embedded in the first stage concrete shall be delivered in due time with instructions and/or templates to facilitate the bringing in of such parts into the Civil works.

30.13.2 All parts to be embedded in concrete shall be set accurately in position and shall be supported rigidly to prevent displacement during the placing of concrete. Adjusting screws and bolts shall be drawn tight and secure adequately. Steel wedges shall be secured by welding. Wooden wedges shall not be used.

30.13.3 The Contractor shall verify carefully the position of all parts to be embedded before concrete is poured. All important measurements and dimensions shall be recorded. Copies of these records shall be given to the Purchaser for checking and approval before items are built-in to the works.

30.14 Temporary Bracing

30.14.1 The Contractor shall provide all necessary anchors and braces to ensure the alignment and stability of the parts to be installed. All temporary anchors and bracings shall take care of all dead load, wind load, ice load, seismic and erection stresses, e.g., during concreting, and shall remain in place until they can be removed without endangering the stability of the plant.

30.14.2 Temporary bracing and attachments shall be fixed and removed in such a way as to prevent damage occurring to the base metal to which they are attached. Projecting welds remaining after this operation shall be ground flush. Tears in the base metal shall be filled with weld and ground flush. After completion of work, the surface shall be restored to proper condition by grinding and repainting.

30.14.3 Welding, torch-cutting and drilling work on the plant to be erected shall only be carried out with the approval of the Purchaser.

30.15 Workmanship

30.15.1 Special care shall be taken not to damage surfaces of galvanized or specially treated plant during erection. Care shall be taken to prevent or remove any rust streaks or foreign maters deposited on galvanized or otherwise finished surfaces during storage or transport or after installation.

30.15.2 Glass parts of other parts which can easily be damaged shall be provided with suitable protective sheaths or coverings during installation.

30.15.3 Machined or bare metal surfaces that are not painted shall be protected during transportation, storage and erection by a suitable anti- corrosion film.

30.15.4 All portable power tools shall preferably be operated pneumatically.

30.15.5 Special tools which are supplied for maintenance and repair can be used for installation. They are to be handed over at the end of the installation work in good condition in accordance with the Purchaser's instruction.

30.15.6 After erection, the works shall be finally painted; it shall be done as far as applicable in accordance with the painting specification, and any damaged paint-work be restored.

30.16 Modifications, Rectifications and Re-Erection

30.16.1 If the dismantling, modifications, rectification, addition etc. is necessitated due to any mismatch/discrepancy in the

fabrication drawing prepared by the Contractor or in fabrication, the Contractor shall be held responsible for the same despite the fact that such drawing might have been approved by the Purchaser. In such cases, nothing extra shall be payable to the Contractor towards carrying out such modification, rectification, addition, dismantling testing, transportation and any other allied activity.

30.16.2 In case, it is found that certain erection marks as already detailed and approved in fabrication drawings require addition, alternation and modification, the same shall be done on the written orders of the Purchaser or his authorised representative.

30.16.3 The work of re-erection include carriage of modified erection marked members from fabrication shop to erection site, lifting of the same to the required position, aligning, erection in position inclusive of bolts and touch up pointing etc. complete to the satisfaction of the Purchaser.

30.16.4 The quoted price shall include all these operation.

31 INSPECTION AND TESTS

31.1 In addition to the provisions established in the Conditions of

Contract regarding general procedure of inspections and tests, terms and definitions, and time schedules for inspections and tests the following stipulations shall apply.

31.2 Purchaser reserves the right to ask for the valid calibration certificate for any instrument to be used for testing or may get the instrument tested by any independent agency.

31.3 Type Tests / Routine Tests / Acceptance Tests / Site Tests

31.3.1 For the specified type tests certificates for the same equipment type, not older than ten years from the date of signing the Contract, shall be submitted for approval by the Purchaser. In case that the test certificates are older than ten years the Contractor shall carry out the specified type tests at his own costs.

31.3.2 Contractor shall have to do all the routine tests, acceptance tests & site tests required as per technical specification & Indian Standards / International Standards.

31.3.3 Contractor shall have the access to the required facilities as stated in the relevant standards to carryout the tests on the various equipments.

31.3.4 In case, contractor does not have the facility to carryout any of the test and intends to carryout the same at some other agency those testing agencies shall be got approved by the purchaser.

31.4 Workshop Inspections and Tests

31.4.1 As far as practicable, quality of materials, workmanship and performance of all items of the work and plant to be furnished under this Contract shall be inspected at the places of manufacture.

31.4.2 When placing orders for material and plant with Sub-suppliers, the Contractor shall send unpriced copies of such orders in triplicate to the Purchaser.

31.4.3 Arrangements shall be made for expediting the shop inspection by having all shop assemblies or pieces covering a single shipment ready at one time. Any painting work as well as transport to the Site of the plant shall not be started before the approval of the Purchaser has been obtained.

31.5 Material Tests

31.5.1 Unless otherwise specified, the quality of materials shall be verified generally by:

chemical analysis	
mechanical tests	(yield point, tensile strength, elongations, notch impact strength, etc.)

welding tests	(welding procedure, welding material, welding tensile strength, welding bend test, welding reversed bend test, etc.)
non-destructive tests	(x-rays, ultrasonic, magnaflux, liquid penetration inspection, etc.)
electrical tests	(voltage, losses, tan delta, insulation, magnetic properties, etc.).

31.5.2 Certified mill test reports of plates will be acceptable when these comply with the requirement for "Reports of Inspections and Tests" as stated in the Special Conditions. Test specimen and samples for analysis shall be plainly marked to indicated the materials they represent.

31.5.3 Castings and forgings shall be tested in the rough state in order to detect flaws in good time thus avoiding delays. Magnetic particle inspection of important castings shall over the whole surface of the casting. After partial machining further tests can be conducted.

31.5.4 Load tests on crane hooks, steel wire ropes, chains, etc. shall be considered as material tests.

31.6 Checking of Dimensions

31.6.1 The dimensions, especially clearances and fits, (ISO 286) which are essential for operation and efficiency shall be carefully checked in an approved manner, as for example:

i) runout and roundness tolerances of shafts. Rotors, pistons, etc., to be measured on single parts as well as (wherever possible) on the assembled components

ii) fits and clearances of bearings, runners, rotors, servomotor pistons, valves, guiding, distributing and actual actuating elements, etc.

iii) accuracy, surface roughness and shape of sliding and guiding surfaces of seals, bearings, water passages in hydraulic machinery, valves, etc.

iv) profiles of turbine runners, pump impellers, etc. to be checked by means of templates

v) dimensions of couplings or connections for assembly with other deliveries from the Contractor, Sub-contractors or other contractors.

31.7 Shop Assembly

31.7.1 In addition to the quality and production control tests, the following shop assembly work and tests shall be made to check measurements, fitting and functioning.

31.7.2 Plant to be furnished shall be shop assembled to a status sufficient to prove that the design and workmanship have been executed in accordance with the Specifications, that the delivery is complete, and that no work remains to be done at Site which reasonably can or should be done in the shop.

31.7.3 Where applicable, each item of the plant shall be assembled completely prior to painting.

31.7.4 Field joints shall be temporarily connected.

31.7.5 All parts shall be properly match marked, identified and doweled where practicable, to facilitate correct and quick field assembly and alignment. Wherever necessary, suitable dowels shall be provided for insertion after field assembly and drilling. The holes for any fitted bolt shall be accurately reamed.

31.7.6 During shop assembly all instruments, control devices and piping shall be fitted.

31.7.7 If the corrections cannot be carried out in accordance with the terms mentioned above, the components concerned will be rejected. The decision on possible subsequent corrections is reserved exclusively to the Purchaser. Faulty parts or plant shall by no means be delivered.

31.7.8 The assembled parts shall subsequently be subjected to tests as per applicable standards of required by the Purchaser.

31.9 Functional Tests

31.9.1 Functional tests shall be defined as tests of the function of assemblies, subassemblies or parts of the plant under no load conditions. Functional tests shall be performed on all plant prior to the execution of operational tests.

31.9.2 Operational Tests

As far as practicable operational test shall be carried out on all plant, simulating operating conditions.

31.9.2.1 Parts to be delivered by sub-suppliers shall be tested either at the premises of the sub-supplier or of the Contractor, as agreed by the Purchaser.

31.9.2.2 Before testing the Contractor shall submit a notice containing full information on the tests with detailed tables or graphs on the latest edition of the characteristic values of the plant to be tested and on the test facilities and equipment.

31.9.2,3 Testing of the electrical plant shall be performed in accordance with applicable Standards; they shall include but not be limited to tests for heating, loading, overloading, losses.

31.9.2.4 Operational tests of lifting equipment and other machinery shall include tests under nominal load and 125% of nominal load unless otherwise specified.

31.9.3 Model Tests

Model tests for certain parts of the work or plant shall be carried out as specified.

31.9.4 Test Reports

Contractor shall have to furnish all the test reports of tests performed on materials, equipments & plants etc. during various stages such as manufacturing, shop assembly etc.

31.9.5 Site Inspection and Tests

31.9.5.1 During erection, commissioning and Test Service Period operation the Contractor shall perform at suitable interval all inspections and tests in the presence of the Purchaser in order to prove the orderly execution of the works in accordance with the Contract.

31.9.5.2 Unless otherwise specified, all costs for testing at Site and of the works and charges associated with it shall be born by the Contractor. This includes the measuring devices, properly calibrated, and any pertinent accessories, which shall be made available by the Contractor for the entire duration of the tests. The Contractor shall delegate his experts to perform the tests at site.

31.9.5.3 For the procedure of inspections and test at Site, notice to the Purchaser, reports, commissioning trial runs and acceptance tests refer to General Conditions.

32 PRE-COMMISSIONING AND COMMISSIONING FACILITIES

32.1 As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included elsewhere in the Technical Specifications.

32.2 The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

32.3 The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

32.4 The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and

turned over to Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed schedule to be agreed by Employer.

32.5 The Contractor during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

32.6 Contractor shall furnish the commissioning organisation chart for review & acceptance of employer at least eighteen months prior to the schedule date of synchronisation.

32.7 Initial Operation

32.7.1 Subsequent to completion of all pre-commissioning activities/ tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.

32.7.2 The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

32.7.3 The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

32.7.4 The Contractor shall intimate the Employer about the commencement of initial operation and shall furnish adequate notice to the Employer in this respect.

32.7.5 Any loss of generation due to constraints attributable to the Employer shall be construed as Deemed Generation.

32.7.6 An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Employer to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects

which do not endanger the safe operation of the equipment, shall not be considered as reasons for with- holding the aforesaid permission.

32.8 Guarantee Tests

32.8.1 The final test as to prove the Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test.

32.8.2 These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the performance guarantees.

32.8.3 For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Employer shall be used. The numbers and location of the instruments shall be as per the specified test codes.

32.8.4 Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Contractor, free of cost.

32.8.5 The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail in the technical specification of each equipment.

33 Taking Over

Upon successful completion of Initial Operations and all the tests conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be with held nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

35 TRAINING OF EMPLOYER'S PERSONNEL

35.1 In addition to the requirements given in Section General Condition of contract (GCC), regarding training of Employer's personnel, the following shall also apply.

35.2 The Contractor shall provide suitable instructors, training material and facilities (instruments, apparatus, simulators, documents, drawings, protective clothing, rooms, office supplies, etc.) for the Personnel made available by the Employer for training.

35.3 One month before the training start, the Employer will send the list of the trainees and any comments on the training program proposed by the Contractor. This program shall be adapted to the design and nature of the Works, and the needs of trainees. Trainees shall be suitably trained in the various aspects of design, manufacture, installation/erection, operation and maintenance, relevant to the training, of works similar to the Works

35.4 The Contractor shall supervise and provide direction to, and be liable for the acts or omissions, other than negligent or wilful misconduct of such personnel, of the Employer's trainees.

35.5 The Contractor shall provide the training described hereafter in accordance with any further specific requirements stated in the Employer's Requirements.

35.6 The Contractor shall assist the Employer in obtaining any visas and other formalities for entering or leaving the territory on which the training is being provided.

35.7 The Contractor shall bear responsibility for ensuring the safety of the trainees during their stay in the country of the training. On their part, the trainees shall comply with the laws, regulations and customs of the country in which training is being held.

35.8 In the event of illness or accident, the Contractor shall take all steps to provide the trainees with the appropriate medical care.

35.9 The Bidder shall provide training to Employer's personnel to meet operational and maintenance requirements of various Systems/equipments supplied under this package.

35.10 The scope of service under training of Employer's engineers shall include a training module covering the following :

35.11 Training During Engineering/ Manufacturing Phase

35.11.1 This shall cover all disciplines viz, Mechanical, Electrical, C&I & QA etc. and shall include all the related areas like Design familiarisation, training on product design features and product design software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. The training in areas of

Operation and Maintenance shall take place preferably during end of manufacture/ tests.

35.12 Training During the Erection / Installation / Site Work

35.12.1 Independently from the supervision and inspection functions of the Employer's Representative, the Contractor shall authorise the Employer's Personnel to follow the erection / installation / site work at his site.

35.12.2 The Employer's Start-up Personnel shall take no part in the equipment erection and/or installation operations, which shall be exclusively carried out by the Contractor and under his entire responsibility.

35.12.3 This on site training shall cover each phase of erection / installation / site work and shall be of sufficient duration.

35.12.4 The Contractor shall supply the information or measurements concerning the erection requested by the Employer's Representative or/and by the Employer's personnel.

35.13 Training during the Tests on Completion phase, Operation & Maintenance

35.13.1 The scope of service under training of Customer's engineers shall necessarily include, training of upto twelve (12) Employer's personnel for the power plant in the areas of Operation & Maintenance The Contractor shall provide on the-job training in the operation and maintenance of the Works to the Employer's Operating Personnel. Such training shall start at least 30 days prior to commencement of Tests on Completion and continue until Taking Over. Its scope and quality shall be such so that the operation and maintenance phase of the project can be carried out to ensure sustained guaranteed performance of the equal availability of the units as offered. The training should provide the trainees with comprehensive understanding of all operational and maintenance aspects of the Works. Such training shall also include safety and environmental protection aspects applicable to the Works.

35.13.2 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal.

35.13.3 In all the above cases, whenever the training of Employer's personnel is arranged at the works of the manufacturers, it shall be noted that the lodging and boarding of the Employer's personnel shall be Bidder's scope. The Bidder shall make all necessary arrangements towards the same.

36 SYSTEM DOCUMENTATION

36.1 The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/

commissioning procedures, instruction/ operating manuals, etc. for each system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these systems/ sub-systems/ equipment at site.

36.2 The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

37 REGULATION OF LOCAL AUTHORITIES AND STATUTES

37.1 In addition to the local laws and regulations the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract.

37.2 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and/or registration shall be borne by the Contractor.

38 ACCESS TO SITE AND WORKS ON SITE

38.1 Suitable access to site and possession of the Site shall be afforded to the Contractor by the Employer in reasonable time.

38.2 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the Employer or his representative.

39 CONTRACTOR'S SITE OFFICE ESTABLISHMENT

The Contractor shall establish a Office at the Site and keep posted an authorised representative for the purpose of the Contract. Any written order or instruction of the Employer or his duly authorised representative shall be communicated to the said authorised resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

40 CO-OPERATION WITH OTHER CONTRACTORS

40.1 The Contractor shall co-operate with all other Contractors or tradesmen of the Employer, who may be performing other works on behalf of the Employer and the workmen who may be employed by the Employer and doing work in the vicinity of the Works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the Employer, due to the Contractor's work shall promptly be made good at his own expense. The Employer shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the Employer in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the Employer on that account other than an extension of time for completing his Works.

40.2 Employer shall give full access to visit the contractor's site at any time for inspection & surveillance checks.

40.3 The Employer shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The Employer shall determine the corrective measures if any, required to rectify this situation after inspection of the works and such decisions by the Employer shall be binding on the Contractor.

41 DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the Employer in respect of his employees and workmen at Site. The Employer shall be at liberty to object to the presence of any representative of employee of the Contractor at the Site, if in the opinion of the Employer such employee has mis-conducted himself or incompetent or negligent or otherwise undesirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

42 CONTRACTOR'S FIELD OPERATION

42.1 The Contractor shall keep the Employer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Employer shall not relieve the Contractor of any of responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the or the Employer or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

42.2 The Contractor shall have the complete responsibility for the

conditions of the Work-Site including the safety of all person employed by him or his Sub-Contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Employer is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.

43 PROTECTION OF WORK

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Employer. No claim will be entertained by the Employer or the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because or other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions contract document. The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

44 EMPLOYMENT OF LABOUR

44.1 In addition to all local laws and regulations pertaining to the employment of labour to be complied by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of his particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.

44.2 All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.

44.3 The hours of work on the Site shall be decided by the Employer and the Contractor shall adhere to it.

44.4 Contractor's employees shall wear identification badges while on work at Site.

44.5 In case the Employer becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contact Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Employer may make such

payments and shall recover the same from the Contractor's Bills.

45 FACILITIES TO BE PROVIDED BY THE EMPLOYER

45.1 Space

The Contractor shall advise the Employer within thirty (30) days from the date of acceptance of the Notification of Award about his exact requirement of space for his office, storage area, pre-assembly and fabrication areas, labour and staff colony area, toilets, etc. The above requirement shall be reviewed by the Employer and space as decided by Employer will be allotted to the Contractor for construction of his temporary structures/ facilities like office, storage sheds, pre-assembly and fabrication areas labour and staff colony, toilets, etc. for Contractor's as well as his Sub-Contractor's use.

45.2 Electricity

The Contractor shall submit to the Employer within thirty (30) days from the date of acceptance of the Notification of Award, his electrical power requirements, if any, to allow the planning of the same by the Employer. The supply of electric power for the main works of construction and domestic purpose will be provided by owner at minimum 2 points (one each at work site & colony) at 11kV, 3 phase 50 c/s . The charges for this purposes will be at the prevailing rate of state electricity utility. The Contractor shall make his own further distribution arrangement. All temporary wiring must comply with local regulations and will be subject to Employer inspection and approval before connection to supply.

45.3 Water

Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite /colony.

45.4 Communication :

The employer will extend the telephone facilities, if available at site, for purpose of contract. The Contractor shall be charged at actuals for such facilities.

46 FACILITIES TO BE PROVIDED BY THE CONTRACTOR

46.1 Contractor's site office Establishment

The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC.

46.2 Tools, tackles and scaffoldings

The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, erection, testing and commissioning of the equipments covered under the Contract. He shall submit a list of all such materials to the Employer before the commencement of pre-assembly at Site.

These tools and tackles shall not be removed from the Site without the written permission of the Employer. The Contractor shall arrange Dozer, Hydra, Cranes, Trailor, etc. for the purpose of fabrication, erection and commissioning.

46.3 First-aid

50.4.46 The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.

50.4.47 The Employer will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.

46.4 Cleanliness

46.4.1 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the Employer. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.

46.4.2 Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Employer. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor.

47 CONSTRUCTION MANAGEMENT

47.1 The field activities of the Contractors working at Site, will be coordinated by the Employer and the Employer decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Employer regarding scheduling and co- ordination of work. Such decision by the Employer shall not be a cause for extra compensation or extension of time for the Contractor.

47.2 The Employer shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Employer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Employer and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Employer may call for other meeting either with individual Contractors or with selected number of Contractors and in such a case the Contractor if called, will also attend such meetings.

47.3 Time is the essence of the Contract and the Contractor shall be

responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Employer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

47.4 The Employer shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

48 FIELD OFFICE RECORDS

The Contractor shall maintain at his Site Office up-to-date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Employer in required number of copies.

49 PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

49.1 The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons including members of public and employees of the Employer and the employees of other Contractors and Sub-Contractors and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.

49.2 The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the Employer and the Employers of public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such Employers, related to removal and/or replacement or protection of such property and utilities.

50 INSURANCE FOR CONTRACTOR'S EMPLOYER AT SITE

50.1 In addition to the conditions covered under the Clause entitled "Insurance" in Section General Conditions of Contract (GCC), the following provisions will also apply to the portion of works to be

done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.

50.2 Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than Workmen's Compensation As per statutory Provisions Employee's liability.

50.3 Comprehensive Automobile Insurance

This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated :

Fatal Injury	:	Rs.100,000 each person
	:	Rs.200,000 each occurrence
Property Damage	:	Rs.100,000 each occurrence

50.4 Comprehensive General Liability Insurance

50.4.1 The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC).

50.4.2 The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.

50.4.3 The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.

ANNEXURE-I

NUMBER OF COPIES OF DRAWING AND DOCUMENTS

(AS APPLICABLE)

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs (SETS)	NO. OF MANUALS (SETS)
1.	PLANT DEFINITION MANUAL	-	3 CD-ROMs	10
2.	Drawings "FOR APPROVAL"	4	1 CD-ROM or Soft Copies by E-Mail	-
3.	Drawings "FOR INFORMATION"	4	1 CD-ROM or Soft Copies by E-Mail	-
4.	Drawings "FINAL DRAWING"	10	3 CD-ROMs	-
5.	Drawings "AS BUILT"	10	3 CD-ROMs	-
6.	DATA SHEETS, DESIGN CALCULATIONS, PURCHASE SPECIFICATIONS, etc. and Other type of documents.			
	i) For Approval	4	3 CD-ROMs/Soft Copies by E-Mail	-
	ii) FINAL	10	3 CD-ROMs	-
	iii) Analysis reports of equipments / structures components / systems employing software packages as detailed in the specifications			
	a) Input	4	3CD-ROMs	-
	b) Output	4	3CD-ROMs	-

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs (SETS)	NO. OF MANUALS (SETS)
	c) Drawings / Sketches	4	3CD-ROMs	-
7.	Erection manual "DRAFT"	-	1 CD-ROM or Soft Copies by E-Mail	4
8.	Erection manual "FINAL"	-	3CD-ROMs	10
9.	Operation & Maintenance manual "DRAFT"	1	1 CD-ROM or Soft Copies by E-Mail	4
10.	Operation & Maintenance manual "FINAL"	-	3CD-ROMs	10
11.	Plant Hand Book "DRAFT"	1	1 CD-ROM or Soft Copies by E-Mail	4
12.	Plant Hand Book "FINAL"	3	3 CD-ROMs	10
13.	Commissioning and Performance Procedure manual "DRAFT"	1	3 CD-ROMs/ Soft Copies by E-Mail	4
14.	Commissioning and Performance Procedure manual "FINAL"	1	3 CD-ROMs	10
15.	Performance and Functional Guarantees test report	8	3 CD-ROMs	
16.	Progress Reports	8	3 CD-ROMs/ Soft Copies by E-Mail	
17.	Project completion report	15	3 CD-ROMs	-
18.	QA programme including Organisation for implementation and QA system manual (with revision servicing)	15	3 CD-ROMs	-

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs (SETS)	NO. OF MANUALS (SETS)
19.	Vendor details in respect of proposed vendors, including Contractor's evaluation report.	1	-	-
20.	Manufacturing QP's, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.			
	i) For review / comment	3	-	-
	ii) For final approval	4	1 CD-ROM 1	
21.	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals			
	i) Draft	-	-	4 sets
	ii) Final	-	2 CD-ROMs	4 sets
22.	Monthly Vendor Approval and QP approval status	2	1 CD-ROM or Soft Copies by E-Mail	
23.	QA Documentation package for items / equipment manufactured and despatched to site.	2	2 CD-ROMs	
24.	QA Documentation Package for field activities on equipment / system at site.	2	2 CD-ROMs	

Annexure-'A'

Quality Assurance & Inspection Requirements of EM Equipments: General Tech. Requirement

SURFACE TREATMENT AND COATINGS

1.00.0. The present specifications apply to equipment and spare part surface coating. They define surface coating, the types of recommended coating, and the associated guarantees. In any case, the Contractor shall submit to the Employer his coating schemes.

1.01.0. CORROSION PROTECTION:

The Contractor shall take all necessary favorable measures to protect equipment from all abnormal corrosion taking into account project specific risks.

In particular, the Contractor shall choose the materials most suited to this project and shall submit a modification request to the Employer when the materials indicated in the specifications are considered unable to guarantee its behaviour against corrosion.

1.02.0. Equipment in Contact with Reservoir Water

For all equipment on the water conveyance circuit (trash racks, valves, pipes, pump turbines instruments), the use of uncoated carbon steel is prohibited, even where corrosion allowance is planned. If he considers it necessary, the Contractor may apply stainless steel cladding to some carbon steel parts, or manufacture these parts in solid stainless steel.

If maintenance is unsure because of peculiar equipment arrangement, or if the equipment cannot easily be shutdown, the Contractor may submit to the Employer, alternative corrosion protection methods, so that vulnerable surfaces can be protected effectively.

1.02.01. Outdoor Exposed Equipment

Among these equipment can be distinguished:

- those figuring as the subject of a particular specification, and for which the nature of materials and corrosion protection is clearly defined,
- those which, unlike the above, are not functional in nature and so are not subject to the same attention regarding problems of corrosion: parapets, gratings, lighting poles, etc.

Even this second category of equipment shall be subject to particular attention with regard to choice of materials and corrosion protection.

In general, attention shall be paid to taking constructive measures or acquiring standard equipment, whatever the function, to avoid any water build-up. Such constructive measures are, for example:

- for constructive using structural sections (dam gates, stoplogs), that all horizontal sheet metal sections have drainage holes at regular intervals;

- for auxiliary structures, embedding holes shall be completely filled with concrete, taking care to avoid any break in corrosion protection where concrete is exposed to the air.

2.00.00. GENERAL:

The Contractor shall provide a complete and reliable surface treatment of the equipment furnished for corrosion protection.

Surface protection shall comprise:

- a surface preparation phase with mechanical cleaning, grit blasting or chemical cleaning,

- a surface treatment phase with either metallizing and application of one or two priming coats suited to the type of metal surface, or application of priming coat,

- an application phase with several coatings of products, including final colored coat.

Surface protection shall be performed either in the Contractor's shops or on site, as per Employer’s Requirement (ER), with the necessary precautions taken.

Finishing touch-ups shall be performed on site upon completion of erection.

3.00.00. SURFACE TREATMENT:

All surfaces to be coated shall first be mechanically or chemically cleaned.

3.01.00. Mechanical Cleaning:

Surfaces shall be mechanically cleaned using one of the following methods:

- shot-blasting or grit blasting,
- Scraping, stripping, mechanical brushing.

3.01.01. Shot-blasting or Grit blasting:

If mineral abrasives are used, they shall be selected in compliance with the prevailing regulations concerning workers' safety.

The required care levels of surface states after cleaning are defined by the illustrations in standard ISO 8501, or equivalent. The required care shall be as follows:

- preparation of steel surfaces to be imbedded set in concrete = Level 1,
- preparation of steel surfaces to receive definitive protection = Level 2.5,
- preparation of steel surfaces to receive metallized protection = Level 3.

The roughness of the cleaned surfaces shall be Ra = 12.5 μm, except for surfaces that shall be metalized later, for which the roughness shall be Ra = 6.3 μm.

3.01.02. Scraping, Stripping, Mechanical Brushing:

This type of cleaning shall concern:

- Parts to be set in concrete, which shall not be coated.

These parts shall be brushed immediately prior to concreting.

- Repair of defective surface coating. In this case, cleaning by scraping, stripping or brushing shall only be performed if shot-blasting or grit blasting is impossible.

The required care shall be as follows:

- St 2 for surfaces which shall subsequently receive a definitive coating.
- St1 for surfaces to be set in concrete with no surface protection.

After cleaning, all surfaces shall be thoroughly dusted.

3.01.03. Surface Protection Repair:

Before surface protection is repaired, the old protection shall be partially or entirely removed. A new defects liability period shall start as soon as the zone in question has been repaired.

The old coating shall be completely removed by shot-blasting or grit blasting, in compliance with the specifications in 3.01.01.

If this process is impossible, the old coating shall be removed by scraping, stripping or mechanical brushing, in compliance with the specifications in 3.01.02.

4.00.00. CHEMICAL CLEANING:

All traces of pollution shall be removed with solvents (degreasing, neutralisation). The surfaces shall then be rinsed and dried (with special cleaning paper).

The Contractor shall submit, for the Employer's approval, a list with the characteristics of the solvents that he intends to use.

5.00.00. SURFACE TREATMENT:

Immediately after surface preparation, the Contractor shall employ one of the following three surface treatment processes:

6.00.00. METALLIZING:

Metalizing shall be performed within 2 hours after preparation.

The chemical composition of the metal used shall be: 85 % Zinc - 15 % Aluminum. The thickness shall be 120 μm.

Application shall be by spray gun in compliance with ISO standards R 2053.

After metalizing, pores shall be plugged by applying a wash primer, or, if the equipment is intended for immersion, by applying a thin coat of zinc epoxy (max. 20 μm).

7.00.00. HOT GALVANIZING:

This coating performed by quenching shall have the following characteristics:

- minimum unit mass : $5 g/dm^2$,
- average thickness : 70 μm

This process shall be used when metalizing cannot be performed under satisfactory conditions.

8.00.00. PRIMARY COAT APPLICATION:

This coating shall have the following characteristics:

- product : zinc epoxy coat,
- thickness : minimum 40 µm.

9.00.00. APPLICATION FOR THE PROTECTION:

The Contractor shall carefully control relative humidity and temperature before and during applying any coating. In any case, the relative humidity shall not exceed 80 %.

All traces of condensation shall be eliminated before protection is applied. If the relative humidity remain between 50 and 80%, the first coat shall be applied four (4) hours after the surface preparation.

The undercoats or finish coats shall be applied in compliance with the drying time required between each application.

10.00.00. TOUCH-UPS:

If more than 20 % of the total surface area of a given zone shall be touched-up, the Contractor shall replace the surface treatment over the entire surface.

11.00.00. PROTECTION OF SURROUNDING SURFACES:

The Contractor shall take every measure to protect the surrounding equipment and surfaces from product spattering, and from any damage caused by the surface preparation that he performs.

Equipment or surfaces that are soiled or deteriorated in spite of these measures shall be repaired or cleaned, or if this is impossible, replaced at the Contractor's expense.

12.00.00. CARBON STEEL – STAINLESS STEEL CONNECTION:

When carbon steel and stainless steel parts are connected, the surface coating shall be prolonged by 50 cm on the stainless steel part.

13.00.00. TYPES OF COATING:

The coatings to be applied, except when expressly stipulated otherwise in the equipment specifications, shall be defined as follows:

13.01.00. CARBON STEEL SURFACES IN CONTACT WITH WATER:

System chosen	Thickness
• 1 zinc epoxy priming coat	40 µm
• 2 or 3 coats of epoxy-coal pitch finishing paint	2 x 225 or 3 x 150 µm

The systems minimum thickness shall be 450 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.02.00. CARBON STEEL SURFACES IN CONTACT WITH AIR AND INSTALLED OUTSIDE:

System chosen	Thickness
• 1 epoxy priming coat	40 µm
• 2 or 3 coats of epoxy-coal pitch finishing paint	2 x 225 or 3 x 150 µm

The systems minimum thickness shall be 450 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.03.00. CARBON STEEL SURFACES UNDER COVER THAT STILL RISK CONDENSATION:

System chosen	Thickness
• 1 epoxy priming coat	40 µm
• 2 coats of colored solvent epoxy pitch	2 x 150 µm

The systems minimum thickness shall be 300 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.04.00. CARBON STEEL SURFACES UNDER COVER WITH NO RISK OF CONDENSATION:

System chosen	Thickness
• Zinc epoxy priming coat	50 µm
• 2 coats of colored solvent epoxy pitch	2 x 100 µm

The systems minimum thickness shall be 200 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.05.00. CARBON STEEL SURFACES IN CONTACT WITH OIL:

System chosen	Minimum thickness
• 2 coats of epoxy-polyamide paint containing aluminum	2 x 75 µm minimum

The contractor shall ensure that the paint chosen is compatible with the oil in contact.

The complete protection shall be applied in the shop.

13.06.00. TEMPORARY PROTECTION OF THE GROOVES:

The grooves, along with an area from 100 to 150 mm on either side of them, shall receive a temporary protective coating, according to the following system:

System chosen	Minimum thickness
• 1 coat of weldable epoxy-zinc paint	40 µm

The complete protection shall be applied in the workshop.

13.07.00. TEMPORARY PROTECTION FOR MACHINED SURFACE:

The surfaces shall be degreased, rinsed and dried before application of the temporary protective coatings.

System chosen	Minimum thickness
• 2 coats for oxidizing surface	2 x 35 µm
• 1 coat for non-oxidizing surface	1 x 35 µm

The protection shall be applied in the shop and eliminated on site before erection, using a rag impregnated with a solvent compatible with the materials temporary protected.

13.08.00. CONDENSATION PROTECTION:

The Employer and Contractor shall mutually agree on the products to be used.

13.09.00. SPARE PARTS:

The spare parts' surface coating shall be applied in compliance with the present specifications.

All temporary surface protections (until the spare parts are used) shall be designed to last for minimum 15 years/ or the period of storage of the parts specified in the ER.

13.10.00. COLOR OF THE FINISH COAT:

The Employer shall define the color of the finish coat**.**

14.00.00. PROTECTION THICKNESS:

Protection thickness shall be checked in compliance with the following specifications:

14.01.00. Number of Measurement Points :

The number of measurement points is defined in the following table:

Size of the surface to be tested (reference zone, in m^2 or in linear meter)	Number of measuring points recommended
< 10	10 to 20
10 to 100	20 to 50
100 to 1000	50 to 100
1000 to 10000	100 to 200

14.02.00. Tolerance on System Minimum Thickness:

Spot measurements less than the minimum thickness shall be accepted if both following conditions are fulfilled:

- the average of all the measurements performed on the reference zone is equal to or greater than the required minimum value, and
- no measurement point is less than 80% of the required minimum value.

In case of non-compliance with the criteria listed here above, the Contractor shall be obliged to touch up surface protection, either locally or completely.

The touch-up procedure shall be submitted to the Employer.

15.00.00. PRODUCT CHARACTERSTICS DATA SHEET:

For each product, the Contractor shall provide a characteristics data sheet specifying:

- the manufacturer's references,
- product characteristics,
- application conditions.

The Contractor shall submit a model data sheet to the Employer. This sheet shall then be used for all surface protection works.

16.00.00. PAINTING/ COATING QUALITY CONTROL SHEET:

During coating operations, the Contractor shall fill out the quality control sheet agreed upon by the Employer and the Contractor.

VOLUME - IIB

SECTION – C1-C

PERFROMANCE GUARANTEE TEST REQUIREMENT

1.0.0. Performance Guarantee 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.

1.1.0 **Testing at site**

Completely assembled crane at site shall be check for 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 site

i. Deflection test of bridge girder at rated load. Crane shall rest on centerline of LT wheels.
ii. Load test and Overload test (running of CT and Hoisting mechanism at 125% of the rated load). Capability of crane to lift the overload from mid-air shall be demonstrated. Electrical tests for brakes, panel, electrical equipment etc. as per IS - 3177
iii. All Other tests as per IS-3177**.**
iv. Load & overload test along with deflection test of lifting beam in line with BHEL approved MQP for lifting beam (if applicable).
v. Speed test at rated load for hoisting, CT and LT mechanism.
vi. Brake test.
vii. Any other test as per IS-3177

viii. The test shall be carried out with actual panel, RRC, Master Controller etc. (as applicable).

VOLUME - IIB

SECTION – C1-D

QUALITY ASSURANCE AND INSPECTION REQUIREMENT

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.

i) Identification, co-relation and verification of material test certificates for the important components like girders, major load carrying components, cross head, hooks, gears, shafts, wheels, wire rope drum, wire rope etc. In absence of Original copy of Mill Test Certificates/ photocopy certified by Mill in original, check test to be carried out and original test certificates to be furnished for each heat/ thickness. For other components supporting test certificates or random check tests shall be conducted / furnished. All test certificates shall be in original and legible. Photocopies certified by Mill/ manufacturer of raw material used, are acceptable.

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.**

ii Welding procedures and welders shall be qualified as per ASME Sec IX . Only qualified welders shall be employed on the job.

iii 100% radiography of tension zone & 25% radiography of compression zone on butt welds of load bearing members shall be carried out with acceptance norms as per ASME Sec VIII Div.1 UW 51. DP test of all butt welds shall be carried out as per ASTM E 165/ ASTM E 109 with acceptance norms as per ASME Sec VIII Div.1 append.8. Radiographs shall be inspected to a sensitivity of 2%.

iv For fillet welds visual inspection on all welds. Die- penetration test (DPT) for fillet welds in the load bearing members as per ASME-165/ASTME 109 and acceptance norm as per ASME section VIII Div. 1.

v 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 dia. 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 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 ASTME 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.

vi. Dye penetration check/ Magnetic particle check on surfaces subjected to hardening process as per ASTM E 165 / ASTM E 138 respectively with acceptance norms as per ASME Sec. VIII Div.1 append.7 for DP check and ASME Sec. VIII Append. 6 for Magnetic particle check.

vii. 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.

viii. 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).

ix Acceptance and routine tests (HV and insulation) for all electrical and electro-mechanical components and system as per governing specification

x. Functional and simulated operation test, sequencing, interlocks, safety, protection and alarm system shall be carried out for Control Panels. Test on CRANE / CRAB motors and other mechanical, electrical, electromechanical as per BHEL technical specification and / or as per applicable code.

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 (running of CT and Hoisting mechanism at 125% of the rated load). Capability of crane to lift the overload from mid-air shall be demonstrated.

c) Electrical tests for brakes, panel, electrical equipment etc. as per IS - 3177

d) All Other tests as per IS-3177.

e) Load & overload test along with deflection test of lifting beam in line with BHEL approved MQP for lifting beam. Reference MQP for lifting beam is attached with this specification.

Procedure No. PEM (Q)/001

SHOP TEST PROCEDURE FOR GEAR BOX

1.0.0	**Scope: Acceptance Norms for Crane Gear Boxes**
1.1.0	This procedure lays down the Acceptance norms for the Gear boxes for EOT crane. This standard also covers vertical gear boxes. Reduction Gears shall be tested for reduction ratio, backlash & contact pattern. Gear Box shall also be subjected to No load run test to check for oil leakage, temp. rise, noise and vibration.
2.0.0	The following dimensions shall be checked:
2.1.0	i. Diameter and keyway dimensions of input and output shafts. ii. Projection of input and output shafts beyond foundation holes and Centre lines of gear box. iii. Centre distance between input and output shafts. iv. Centre Height. 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. vi. Overall dimensions
3.0.0	**Backlash**
3.1.0	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
4.0.0	**Area of Contact:**
4.1.0	Area of contact shall be taken by applying Prussian blue. The contact area shall be within the limits mentioned below (refer Figure –2) For final stage of Hoist gearing: h / H shall be more than 30% (a – c) / b shall be more than 40% For all other gears: h / H shall be more than 40% (a – c) / b shall be more than 50%

5.0.0	Running Test
5.1.0	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: i. All bolts at the joints remain tight ii. All gear mesh lines are getting enough lubrication iii. All bearings are getting enough lubrication 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. v. Vibration : Maximum limit 125 microns (peak to peak) 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. vii. There shall be no Oil leakage at parting lines, bearing housings or inspection covers.
6.0.0	General
6.1.0	In addition to the above specific points, the following general points shall be ensured: i. Inspection pockets are provided as required. ii. Gear box casings are provided with at least two fit bolts/dowels at the parting line. iii. Dip sticks with minimum / maximum level markings are provided. iv. Drain plugs are provided at convenient locations preferably at vertical wall of the housing. v. Breathers are provided. vi. Lifting lugs or eye bolts ar provided as required. vii. Wherever bearings have splash lubrication, oil retainers are provided. viii. Gear boxes are painted as per specification outside and inside. Inside surfaces shall be painted with Oil proof paint. ix. In case of vertical gear boxes having more than two stage reduction, forced lubrication is also provided. Name plate should provide information eg. Ratio, KW rating, Bearing details and manufacturers name.

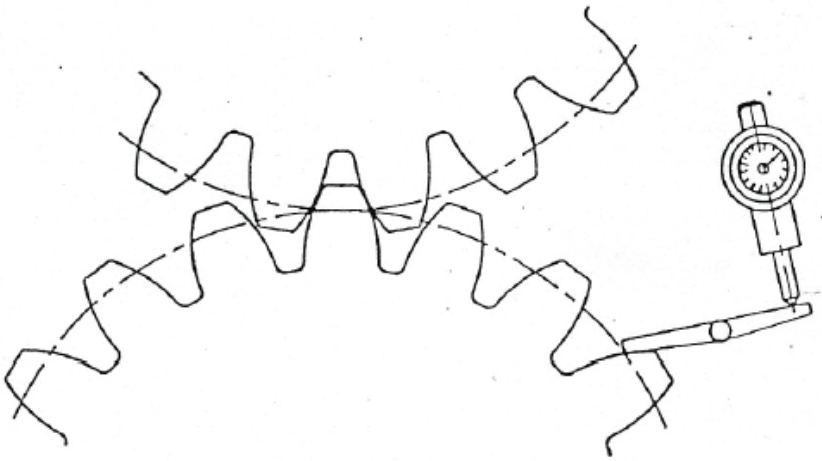


FIG.1 MEASUREMENT OF BACKLASH

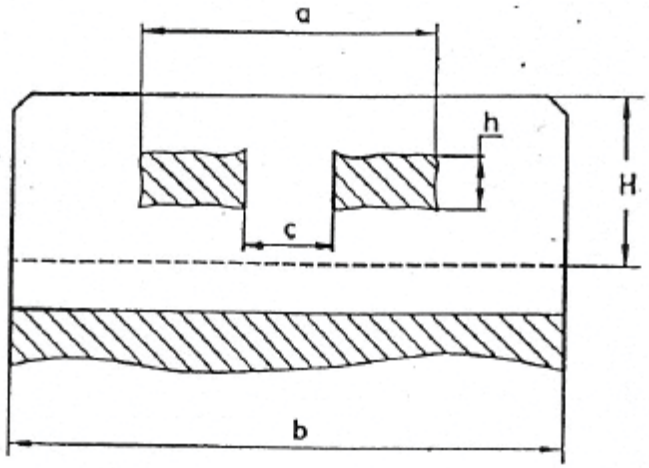


FIG.2 AREA OF CONTACT OF GEAR TEETH

Table-1

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 1 to 50	**For all modules 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

Procedure for Load/Overload testing of Power House EOT cranes at Manufacturer's Works

Objective: To demonstrate final No load, Load, Overload, Deflection, Functional tests of assembled crane for the purpose of acceptance.

Basic Assumptions / Inputs for testing at Works:

- Actual job hook shall be used for load and overload tests for hoisting.
- Actual ropes shall be used for load and 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.

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 and 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. Resisters 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 :

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 shop 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 bidder's works.

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1	4		3	4	5	6	7	8	9	D*	**	10		11	
1	Fabricated components														
	Box Girder, End Carriage, Crab Frame, Rope Drum														
a	Material		Chemical & Physical Properties	Major	Corelation with T.C./ Check test in absence of T.C.	1/Heat/Batch	E250 Grade BR IS: 2062	E250 Grade BR IS: 2062	Mfr's T.C/ Check Test Report	√	P	V	V	Refer note: 1	
			U.T of plates.		Ultransonic	100%	ASTM A435	ASTM A435	T.C. / I.R.	√	P	V	V	U.T. ON ABOVE 25MM THICK PLATE	
b	weld setup		dimensions	Major	Measurement	100%	Components drawings	Components drawings	Vendor's inspection report		P				
1A	Seamless pipe for rope drum		Chemical & Physical Properties	major	Corelation with T.C./ Check test in absence of T.C.	100%	ASTM A106Gr B	ASTM A106Gr B	Mfr's T.C/ Check Test Report	√	P	V	V	Refer note: 1	
			NDT	Major	Macro etching & flattening	100%	ASTM A106Gr B	ASTM A106Gr B	MTC/Lab TC	√	P	V	V		
			NDT	Major	UT	100%	ASTM E-213-2007	Notch depth shall not be more than 12.5% of thickness of pipe	UT Report	√	P	V	V		
2	Welding WPS (Welding procedure specification) in line with ASME sec. IX (QW - 482) - For Box Girder, End Carriage, Crab Frame, Trolley Gear Box Casing & Rope Drum														
a	Check for welding procedure qulification, welder's performance		Welding parameters	Major	Review of documents	100%	ASME Sec-IX	ASME Sec-IX	QW-482,QW-483, QW-484 as per ASME Sec-IX	√	P	V	V	WPS/PQR/WPQ approved/ reviewd by NTPC/ NPCIL/ BVI/ LLOYES/TUV etc. shall be accpetable	
b	Back chipping		surface defect	Major	DPT	100%	ASME Sec-VIII, Div-I, Appen - 8	ASME Sec-VIII, Div-I, Appen - 8	DP Report	√	P	V	V		
c	Butt Welds		NDT	Critical	RT	100% in tension, 25% in compression, 100% in rope drum	ASME Sec-V	ASME Sec-VIII, Cl UW-51 & 52	RT Report	√	P	V	V		

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP					
									PACKAGE : DOUBLE GIRDER CRANES					
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :					
							REV : 0		CONTRACTOR :					
							DATE :		VENDOR' S QAP No :					
SL.	COMPONENTS &	CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS
NO.	OPERATION			CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N	
1	4	3	4	5	6	7	8	9	D*	**	10		11
			Critical	DPT	100%	ASME Sec-V	ASME Sec-VIII, Div-I, Appen - 8	DP Report	√	P	W	V	DP test of fillet weld for rope drum to be conducted. After final machining random witness by BHEL
d	fillet welds	Size and surface defects	Major	Visual	100%	Manufacturing drawing	Manufacturing drawing	Vender inspection Report	√	P	V	V	
		NDT	Major	DPT	10% RANDOM	ASME Sec-V	ASME Sec-VIII, Div-I, Appen - 8	Vender inspection Report	√	P	W	V	
e	final insection of fabricated components listed in Sr.1 above	Dimensions for Girder, end carriage rope drum etc. Camber, Verticality, bend etc	Major	Dimensional Measurement	100%	Vendor Mfg. Drg.	Vendor Mfg. Drg.	vendor inspection report	√	P	V	V	
f	Heat treatment of rope drum	Stress relieving	Major	Review of SR chart	100%	Approved drawing/relevant standard	Approved drawing/ relevant standard	SR Chart	√	P	V	V	If fabricated from M.S Plate
3	Gear box casing												
a	Material	Surface condition	Major	Visual	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report	√	P	V	V	Refer note 1
		Chemical & mech	Major	Measurement Correlation with T.C. Check test in absesnce of T.C. Correlation	100%	Manufacturing drawing/ IS: 2062	Manufacturing drawing/ IS: 2062	T.C. & I.R.	√	P	V	V	

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1	4		3	4	5	6	7	8	9	D*	**	10		11	
b	Dimension		Dimensional conformity	Major	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report		P				
c	Heat treatment		stress relieving	Major	Review of SR chart	100%	Approved drawing/relevant standard	Approved drawing/ relevant standard	SR Chart	√	P	V	V		
4	PLATFORMS		Dimensional conformity	Minor	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report	√	P	V	V	Refer note: 1	
5	L.T.FRAMES		Dimensional conformity	Minor	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report	√	P	V	V		
6	HAND RAILINGS		Dimensional conformity	Minor	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report	√	P	V	V		
7	CABIN		Dimensional conformity	Minor	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report	√	P	V	V		
8	Current collector arms		Dimensional conformity	Minor	Measurement	100%	Mfr. Catalog	Mfr. Catalog	Vendor inspection Report	√	P	V	V		
9	DSL Guard		Dimensional conformity	Minor	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report	√	P	V	V		
10	Rails		Dimensional conformity	Minor	Measurement	100%	G.A.drg./IS : 3443 Vendore T.C./Appd.Data Sheet	G.A.drg./IS : 3443 Vendor T.C./Appd.Data Sheet	Vendor inspection Report	√	P	V	V		
			Chemical , tensile & hardness	Major	Chemical & hardness	100%	IS-3443	IS:3443	Manufacturer TC	√	P	V	V		
11	MECHANICAL COMPONENTS														
A	a) wheels														

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1	4		3	4	5	6	7	8	9	D*	**	10		11	
	i) raw material		Chemicals composition and Mechanical Proporties.	Major	Corelation with Mfr's TC	100%	Mfg.drg./IS:1570 / BS - 970	Mfg.drg./IS:1570 / BS - 970	Test Certificate	√	P	V	V	Refer Note:1	
	ii) Machined		a) Dimensions	Major	Measurement	100%	Manufacturing drawing	Manufacturing drawing	Vendor inspection Report		P	V	V		
			b) Hardness		Mechanical	100%	Approved Data Sheet / Mfg. Drg.	Approved Data Sheet / Mfg. Drg.	Vendor inspection Report	√	P	V	V		
			c) UT		NDT	100%	ASTM A 388	ASTM A 388	Vendor inspection Report	√	P	V	V	Refer UT procedure	
			d) DPT		NDT	100%	ASME Sec-VIII-App-8	ASME Sec-VIII-App-8	Vendor inspection Report	√	P	W	V		
	b) Raw material for Gears , Pinions, Shafts,Axles etc		i) Chemicals Composition & heat treatment, Physical Properties.	Major	Correlation with Mfr's TC/ Check test in absence of TC	100%	Manufacturing drawing, BS : 970 / IS : 1570 / Approved Data Sheet	Manufacturing drawing, BS : 970 / IS : 1570 / Approved Data Sheet	Mfr's T.C/ Check Test Report	√	P	V	V		
			ii) UT (after machining)	Major	check for UT (abov	100%	ASME Sec-V	Refer UT procedure	Vendor inspection Report	√	P	V	V		
			iii) Hardness	Major	check for Hardness	100%	drg. & Approved Data Sheet	Mfg. drg. & Approved Data Sheet	Vendor inspection Report	√	P	W	V	Hardness witnessing by BHEL before teeth cutting.	
			iv) Dimensions	Major	Measurement	100%	Mfg. Drawing	Mfg. Drawing	Vendor inspection Report	√	P	V	V		
			V) D.P.Test on teeth	Major	NDT	100%	ASTME-165	No linear indication	Vendor inspection Report	√	P	V	V		
	c) Casting for Gears and pinions, if applicable		Chemical and Physical	Major	Chemical and Physical	100%	Approved drg/ data sheet	Approved drg/ data sheet	Mfr's T.C	√	P	V	V		
			NDT	Major	U.T.	100%	ASTM A 388	ASTM A 388	Vendor inspection	√	P	V	V	Refer UT procedure	
B	Pulleys, Brake drums, coupling & other major steel castings & forging														
	i) Materials		Physical/Chemical/Hardness	Major	Corelation with mfr's TC	100%	Mfg. Drawing	Mfg. Drawing	Mfr's T.C.	√	P	V	V		

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1	4		3	4	5	6	7	8	9	D*	**	10		11	
	ii) Machined		a) Dimensions	Major	Measurement	100%	Components Drawing	Components Drawing	Vendor inspection Report		P	V	V		
			b) DPT after machining.	Major	NDT	100%	ASTM E-165	No linear indication	Vendor inspection Report	√	P	V	V		
C	Gear box assy & idle running		Check for oil leakage,Noise level,vibration backlash, rise in temp. after 2 Hrs. of running, reduction ratio, backlash and contact pattern	Major	Visual & Measuren	100%	Vendor standard	Smooth running no oil leakage, Noise 85 db at 1 Mtr. Max. Temp. rise 30°C above amb temp.	Vendor inspection Report	√	P	V	V		
D	a) Top block, bottom block		dimensional conformity	Major	Masurement	100%	Assembly drawing	Assembly drawing	Vendor inspection Report		P	V	V		
	b) Hook		i) Chemical composition, Heat treatment, Mechanical properties on integeral test bar	Major	Chemical, heat treatment & Tensile , % elongation	100%	IS:1875		Test Certifacte , HT chart & Insp. Report	√	P	V	V		
			ii) UT on raw material of hook	Major	UT	100%	ASME sec--v	Annex-1 (Attached)		√	P	V	V		
			iii) Forging operation of hook	Major	Visual	100%	IS:5749 /IS:15560	IS:5749 /IS:15560		√	P	V	V		
			iv) Proof load test	Major	Mechanical	100%	IS:5749 /IS:15560	IS:5749 /IS:15560		√	P	W	V		
			v) UT & MPI after proof load test	Major	UT & MPI	100%	ASME sec - v	Annex-1 for UT & No crack & linear indication (For MPI)		√	P	W	V		
			Identification Punch (By BHEL &/or customer, after proof load & NDT witness)	Major	Visual	100%	-----	-----	-----	-	P			CHP - Customer Hold Point	
E	Rope drum assembly		Diemnsion	Major	Measurement	100%	Mfg. Drawing	Tolerance as per drg	Vendor insp Report		P	V	V		
12	Electrical components														
a)	Motors (=< 50 KW)		make , type , rating, Routine test	Major	Review mfr's TC	100%	IS:325	IS 325/Mfr's T.C.	Mfr's T.C.	√	P	V	V	Refer Note 3. For Motor above 50kW separate QP shall be followed.	

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1	4		3	4	5	6	7	8	9	D*	**	10		11	
b)	Brakes		Make , type , rating , dia , Functional test /Routine test	Major	Review mfr's TC	100%	Appd drgs	Appd drgs	Mfr's T.C.	V	P	V	V		

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
वी पी ई पी सी					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1	4		3	4	5	6	7	8	9	D*	**	10		11	
c)	Control panel		Interlocking fuctional, IR, HV, Sheet thikness, cable laying, dressing , ferulling Overall diemsnions , painting shade, Panel surface finish, Paint Thickness, adhesive test, Component fixing, Degree of protection by paper inserting method	CR	Test for HV, IR, functional check	100%	IS : 3177 / App. Panel Drg. & BOM/ Data sheet	IS : 3177 / App. Panel Drg. & BOM/ Data sheet	Vendor insp Report	√	P	W	V	Refer Note No. 4 VVVFD Test Certificate to be submitted from app. Vendor for verification.	
d)	Radio remote, Master controller		HV, IR,Functional	Major	Verfication	100%	BOM/ Mfr. Catalogue	BOM/ Mfr. Catalogue	Mfr's T.C.	√	P	V	V	Refer Note No. 4	
e)	Limit switches		Functional	Major	Verfication	100%	Approved drawings	Approved drawings	Mfr's T.C.	√	P	V	V		
f)	Trailing cable, Power Control Cable & DSL		Make , type , rating ,Routine & aceptance test insulation resistance values	Major	Verfication	100%	IS: 9968, IS 1554-Part-1	IS: 9968, IS 1554-Part-1	Mfr's T.C.	√	P	V	V		
g)	Transformer		make rating , routine test	Major	visual	100%	Appd drg	Appd drg	Mfr's T.C.	√	P	V	V		
h)	SFU, MCCB,MCB, Contactors, DSL, relays, fuses, resitance bank		make, t ype , rating size, functional, continuity check	Major	visual	100%	Appd drg	Appd drg	Mfr's T.C.		P	V	V		
i)	VVVF drives		make , type , rating, routine test	Major	visual	100%	Appd drg	Appd drg	Mfr's T.C.		P	V	V		
j)	Anti collision devices , cable gland , ,lugs ,r ectifier, indicating lamps, terminal blocks, load cell.		make , type	Major	visual	100%	Appd drg	Appd drg	Mfr's T.C.		P	V	V		
13	Bought out items														
a)	Wire rope		Visual , tensile	Major	Type, grade, dia br	100%	IS:2266	IS:2266	Mfr's T.C.	√	P	V	V		
b)	Bearing		Type & Size	Major	Verfication	100%	Appd drg/Mfr's catalogue	Appd drg/Mfr's catalogue	Mfr's T.C.	√	P	V	V		
14	Assembly of cranes														
a)	Bridge with LT		Dimesions, wheel level alignment	Major	Measurement	100%	GA drg/IS:3177	GA drg/IS:3177	Insp. Report	√	P	W	V		
b)	Crab assembly		Dimesions, wheel level alignment	Major	Measurement/ Vis	100%	GA drg/IS:3177	GA drg/IS:3177	Insp. Report	√	P	W	V		

		MANUFACTURER'S NAME & ADDRESS			STANDARDARD MANUFACTURING QUALITY PLAN				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP					
									PACKAGE : DOUBLE GIRDER CRANES					
बी एच ई एल					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :					
							REV : 0		CONTRACTOR :					
							DATE :		VENDOR' S QAP No :					
SL.	COMPONENTS &		CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS
NO.	OPERATION				CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N	
1	4		3	4	5	6	7	8	9	D*	**	10		11
c)	Final Inspection (at works) with actual panel and pendent		Overall dimension: Span, Diagonal dimension check, Wheel base & gauge, overhang, LT Stopper, headroom, lift , Eqp. Layout on bridge platform, , elevations /levels etc	Major	Measurement	100%	Approved drgs./IS :3177	Approved drgs./IS: 3177	Insp. Report	√	P	W	W	
			No Load & Load Tests											
			a) No load: Hoists,CT & current measurement, No Load running of LT machinery for direction and speed with VVVFD	Major	Measurement	100%	Approved drgs	Approved drgs	Insp. Report	√	P	W	W	
			b) SWL: Hoists, CT speed, current & Deflection measurement	Major	Operational Check & Measurement	100%	GA drg/ IS:3177/ Approved Drawing	GA drg/ IS:3177/ Approved Drawing	Insp. Report	√	P	W	W	
			c) Overload: Hoisting, CT movement & current measurment (at 125% SWL)	Major	Operational Check & Measurement	100%	GA drg/ IS:3177/ Approved Drawing	GA drg/ IS:3177/ Approved Drawing	Insp. Report	√	P	W	W	
			d) Operation check of brakes and limit switches .	Major	Operational Check	100%	GA drg/ IS:3177/ Approved Drawing	GA drg/ IS:3177/ Approved Drawing	Insp. Report	√	P	W	W	
15	Painting		Surface preparetion & Painting. DFT	Major	Visual	100%	Approved drgs/doc	Approved drgs/doc	Vendor's Report		P	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.													
Note 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 equvalent which gives enough readable and interpretable film quality to be used for clarity. All NDT shall be carried out by Qualified Level II personnel.													
Note 3 :	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.													

		MANUFACTURER'S NAME & ADDRESS			**STANDARDARD MANUFACTURING QUALITY PLAN**				PROJECT: 4x111 MW VISHNUGAD PIPALKOTI HEP						
									PACKAGE : DOUBLE GIRDER CRANES						
					ITEM:		QP NO : PE-TS-413-501-A001		CONTRACT NO :						
							REV : 0		CONTRACTOR :						
							DATE :		VENDOR' S QAP No :						
SL.		COMPONENTS &	CHARACTERISTCS	CLASS	TYPE PF	QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY			REMARKS	
NO.		OPERATION			CHECK	OF CHECK	DOCUMENT	NORMS	RECORDS		M	C	N		
1		4	3	4	5	6	7	8	9	D*	**	10		11	
		30 KW to 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: 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, space heater and tested in accordance with approved drawing /data sheets														
Note 4 :		Performance of electrical & control devices along with the interlocks, protection & sequence to be checked during crane assembly and parked at works.													
Note 5 :		All material of construction shall be as per approved drg. / data sheet / specifications													
LEGEND :															
D: RECORDS INDETIFIED WITH 'TICK'(√) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION															
M : MANUFACTURER/SUBCONTRACTOR															
C: BHEL-CQS/THIRD PARTY															
N: CUSTOMER															
INDICATE "P" PERFORM "W" WITNESS AND "V" DOCUMENT REVIEW															
MANAFACTURER/		CONTRACTOR													
SUBCONTRACTOR															
SIGNATURE			N : CUSTOMER					REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL						

ULTRASONIC TEST PROCEDURE

1.	Specification Applicable	:	(I) **ASTM A – 388**
2.	Test Purpose	:	This test conducted on Round Bar, Forging Blank & Hook material (Before Forming) to detect Internal Defect.
3.	Condition of material	:	As rolled/ Normalized Surface shall be prepared as Necessary for conducting the ultrasonic test.
4.	Method	:	Contact method using with pulse-back echo.
5.	Equipment details	:	Modsonic Instrument/ EEC- PX-10
6.	Scanning Area	:	Scanning shall be done in 100% area direction all Along the length and width scanning shall be done at ±6 db. Evaluation shall be done at reference level.
7.	Couplant	:	Oil/Water
8.	Calibration block	:	The ultrasonic flow detector shall be calibrated by Using standard calibration block IIW V1, V2.
9.	Probe used Probe	:	Probe dia 24mm, 2MHz, 4MHz (NB) dia 10mm x 4MHz, 24 mm Dia x 2MHz (NB) (For Hook)
10.	Calibration	:	By choosing proper depth range and gain, the back Wall echo from a defect free area shall be brought To **100 %** full screen height (FSH). This shall be The reference level.
11.	Acceptance Norms	:	Loss of back echo: More than 20% not acceptable. Defect echo more than 20% not acceptable. Any indication characterized as cracks, lamination, Or any linear defect is not acceptable.
12.	Personnel Qualification	:	The ultrasonic test shall be carried out and results are Evaluated by a person qualified to ISNT/ASNT LEVEL-II.

MANUFACTURER NAME & ADDRESS	MANUFACTURING QUALITY PLAN		TECHNICAL SPECIFICATION: PE-TS-413-501-A001
	ITEM: LIFTING BEAM ASSEMBLY FOR **W.O.NO**:	BHEL DOC. NO. : REV : DATE :	PROJECT : 4x111 MW VISHNUGARH HEP CLIENT : BHARAT HEAVY ELECTRICAL LTD.

SR. NO.	COMPONENT & OPERATIONS	CHARACTERISTIC	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	D	10			11
1)	**For Lifting beam (Lower & Upper Lifting Beam)**									**M**	**C**	**N**	
i)	Material	Chem. & Phy.	Major	Co-relation with T.C. Check test in absence of T.C.	1/heat/batch	Drg. / Tech. Spec. / IS:2062:2006 , GR-BR, (E250) , AMD.1 ,2009	Drg. / Tech. Spec. / IS:2062:2006 , GR-BR, (E250) , AMD.1 ,2009	MTC	✓	P	R	R	
		NDT	Major	U.T	100%	ASTM A 435	ASTM A 435	I.R	✓	P	R	R	UT on 25 mm & above thick plate
ii)	Weld set up	Dimensional conformity	Major	Measurement	100% for butt weld joint	Component drawing	Component drawing	I.R	-	P	-	-	
iii)	Pins for Slings & Hooks	Chem. & Phy.	Major	Co-relation with T.C. Check test in absence of T.C.	100%	Mfg.drg/EN-9(070M55) / BS - 970-1983	Mfg.drg/EN-9(070M55) / BS - 970-1983	I.R	✓	P	R	R	
		NDT	Major	U.T	100%	ASTM A 388	ASTM A 388	I.R	✓	P	R	R	IF DIA >= 50mm UT to be Applicable.
iv)	Wire rope	Make, construction , breaking strength	Major	Visul corelation with TC	100%	IS:2266 / As Per Drg.	IS:2266 / As Per Drg.	MTC	✓	P	R	R	
2)	**Welding**												
i)	WPS , WPQ & PQR	Welding parameters	Major	Review of earlier appd. WPS/WPQ/ PQR records	100%	ASME SEC IX	ASME SEC IX	WPS/WPQ/ PQR records as per ASME SEC - IX format	✓	P	R	R	WPS already approved by LIOYDS/NTPC/NPCIL shall be valid. In case NTPC/BARC/NPCIL/ IRS/TPL/LIOYDS qualified welders already available & doing the same job regularly, re-qualification is not required. Alternatively welder qualified by above agences will be utilised.
ii)	Back chipping	Surface defects	Major	DPT	100%	ASME Sec.V	ASME - Sec. VIII Div 1 Appen.-8	-		P	R	-	

MANUFACTURER	CONTRACTOR (BHEL)	SIGNATURE

LEGEND:
RECORDS IDENTIFIED WITH 'TICK (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION
"M" MANUFACTURER/ SUBCONTRACTOR
"C" CONTRACTOR (BHEL)
"N" CUSTOMER
INDICATE "P" PERFORM, "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE.
" CHP" SHALL IDENTIFIED IN COLUMN " N "
NOTE: ITEMS NOT COVERED IN MQP, MAY BE CLEARED ON BASIS OF "CERTIFICATE OF CONFIRMANCE"

FOR CUSTOMER USE	REVIEWED BY	APPROVED BY	APPROVAL SEAL

MANUFACTURER NAME & ADDRESS	MANUFACTURING QUALITY PLAN		TECHNICAL SPECIFICATION: PE-TS-413-501-A001
	ITEM: LIFTING BEAM ASSEMBLY FOR **W.O.NO**:	BHEL DOC. NO. : REV : DATE :	PROJECT : 4x111 MW VISHNUGARH HEP CLIENT : BHARAT HEAVY ELECTRICAL LTD.

SR. NO.	COMPONENT & OPERATIONS	CHARACTERISTIC	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	D	10			11
										M	C	N	
a)	Butt-Weld	Weld Quality	Critical	RT	100% in tension & 25% in compression	ASME SEC VIII	ASME SEC VIII Clause UW - 51	RT report & Film	✓	P	R	R	Review of radiography report
			Major	DPT	100%	ASME Sec.V	ASME SEC VIII Appnd. 8	I.R	✓	P	R	R	
b)	Fillet Weld	Surface defect & size	Major	Visual	100%	Component Drawing	Component Drawing	I.R	✓	P	R		
			Major	DPT	10% at random	ASME Sec.V	ASME Sec. VIII	I.R	✓	P	**W**	R	W - At the time of final Inspection of Lifting beam
iii)	Inspection of Fabricated Lifting Beam	Visual & dimensional	Major	Dimensional & measurement	100%	Individual component drawing	Individual component drawing	I.R	✓	P	R	R	
3)	Final assembly of Lifting beam	Visual & Dimensional	Major	Visual & Dimensional check	100%	GA Drawing of lifting beam / IS 3177 / Tech-Specification.	GA Drawing of lifting beam / IS 3177 / Tech-Specification.	I.R	✓	P	**W**	**W**	CHP (AT WORKS)
4)	Review of QA Documents	-	-	-	-	-	As per approved QAP	-	-	R	R	R	
5)	Load test at Mfg. Works as well as Site	Visual	Major	Visual	100%	Appd drawing / Load test procedure	Appd drawing / Load test procedure	I.R	✓	P	**W**	**W**	
		Deflection test at SWL	Major	Measurement	100%			I.R	✓	P	**W**	**W**	
		Overload test at (1.05 x SWL)	Major	Visual	100%			I.R	✓	P	**W**	**W**	Overload test to be performed at @ 1.05 X SWL

LEGEND:
RECORDS IDENTIFIED WITH 'TICK (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION
"M" MANUFACTURER/ SUBCONTRACTOR
"C" CONTRACTOR (BHEL)
"N" CUSTOMER
INDICATE "P" PERFORM, "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE.
" CHP" SHALL IDENTIFIED IN COLUMN " N "
NOTE: ITEMS NOT COVERED IN MQP, MAY BE CLEARED ON BASIS OF "CERTIFICATE OF CONFIRMANCE"

MANUFACTURER	CONTRACTOR (BHEL)	FOR CUSTOMER USE			
SIGNATURE			REVIEWED BY	APPROVED BY	APPROVAL SEAL

1.0 SCOPE

This covers the guidelines for load testing of lifting beams of EOT cranes.

2.0 ACCESSORIES AND FACILITIES NEEDED.

a) a) Slings of suitable size and length, proof load tested at 2 X Safe working load (SWL).
b) b) Jacking system.
c) c) Supporting structure
d) d) Test loads.
e) e) Cradle for accommodating test load (if required).

3.0 PROCEDURE

a) Support the lifting beam on fabricated structure and hydraulic jacks at both ends as indicated in the attached sketch no LB/001.
b) Place the load to be lifted under the lower lifting beam. Total test load shall be 1.25 times the SWL.
c) Drop the lifting slings from the lifting beam and safely tie it with the load.
d) The sling should be tied with the lifting beam such that the slings should not be slack.
e) This should ensure that the slings are in full tension when the lifting beam is elevated by at least 100mm.
f) Fix the necessary measuring instrument in the lifting beam with wire and plumb to measure the initial reading for vertical deflection of both lower and upper lifting beam.
g) Now elevate the lifting beam by means of hydraulic jacks, such that the lifting beam is elevated by at least 100mm.
h) Ensure that the whole load is lifted clear from the floor.
i) Ensure that the elevation is equal at both ends.
j) Now the load is lifted by 100 mm and hence the sling is in full tension.
k) Keep the load in lifted condition for one minute.
l) Measure the deflection of the lifting beam structure.
m) Bring down the lifting beam to its original position with the help of jack.
n) Make the lifting beam free from testing position and put in safe place.
o) Visually check the weldments of lifting beam and carryout DP test in case of doubt.

4.0 REMARKS

a) 1) The dimensions of stand, cradle etc. in sketch no LB/001 are illustrative only. Bidder to make suitable arrangement as per their shop facility.
b) 2) In case the bidder has test pit facility instead of stands (illustrated in sketch LB/001), the same can also be used.

E.O.T. CRANES

1.00.00 HOOKS

1.01.00 All tests including Proof Load Test as per relevant IS, BS / DIN shall be carried out.

1.02.00 MPI/DPT shall be carried out after Proof Load Test.

2.00.00 **STEEL CASTING**

2.01.00 DPT on machined surface shall be carried out.

3.00.00 **GIRDERS, END CARRIAGE,CRAB, GEAR BOX,AND ROPE DRUM**

3.01.00 The plates of thickness 25mm and above shall be ultrasonically tested.

3.02.00 NDT requirements on weldments shall be as follows:

Butt welds in tension:-	100% RT and 100% DPT
Butt welds in compression: -	25% RT and 100% DPT
Butt welds in rope drum: -	100% RT and 100% DPT
Fillet welds :-	RANDOM 10% DPT

4.00.00 **FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)**

All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonically tested.

Forging should be checked for physical & chemical properties and treatment as per relevant IS.

4.01.00 DPT/MPI shall be done after hard facing and machining.

4.02.00 Wire Rope shall be tested as per IS 3177, IS 2266, IS 13870.

4.03.00 Reduction Gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no load run test to check for oil leakage, temperature rise, noise and vibration.

Reduction gears, shafts, pinions etc shall be checked for dimensions, hardness, ultrasonic testing after proof machining and DPT on teeth.

4.04.00 The Cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per IS-3177 shall be carried out at shop.

4.05.00 All Electric Hoists shall be tested as per IS-3938 and chain blocks shall be tested as per IS-3832.

4.06.00 LIFTING BEAM TEST:

Lifting Beam shall be submitted to suitable tests including overload test during manufacturing at works.

4.07.00 The Contractor shall have to carryout the full load and percent over load tests at the manufacturer's works for this hoisting motion of the cranes/hoists as per relevant IS. Concentricity of each wheel of gantry shall be checked with dial gauge.

5.00.00 **Pulley and Brake Drum**

a) Material – pulley and rope drum material shall be checked for physical & chemical properties as per relevant IS.

b) DPT shall be done for the grooves of rope pulleys.

6.00.00 **L.T/ C.T Wheels (Longitudinal Travel; Cross Travel):**

1) Material shall be checked for chemical & mechanical properties.

2) Machined Wheels – i) to be checked for dimensions, hardness, UT, & DPT as per relevant IS

SUPPLIER'S LOGO	SUPPLIER'S NAME AND ADDRESS	**FIELD QUALITY PLAN**		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :
		ITEM : SUB-SYSTEM:	QP NO.: REV. NO.: DATE: PAGE: ….	

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK #	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	**LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;** **'A'** SHALL BE WITNESSED BY OWNER FQA, **'B'** SHALL BE WITNESSED BY OWNER ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)	FOR THDC USE	DOC. NO.:		REV……
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

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

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

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER
SIGNATURE	

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** MANUFACTURER/SUB-SUPPLIER **C:** MAIN SUPPLIER, **T:**: OWNER; **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** OWNER SHALL IDENTIFY IN COLUM "N" AS ' W"

FOR OWNER USE

DOC. NO.:		REV…… CAT…..
REVIEWED BY	APPROVED BY	APPROVAL SEAL

VOLUME - IIB

SECTION – C1-E

DATASHEET A

DATA SHEET FOR DOUBLE GIRDER EOT CRANE WITH VVVF DRIVES

'*' marked information are to be furnished by bidder during detail engineering stage only

S.N.	Description	Technical Particulars	
		For Power House area	For Butterfly valve House area
1.0.0	**General**		
1.1.0	**Name of manufacturer**	*	
a.	EOT Crane	*	
b.	Crane motors	*	
c.	Runway conductors	*	
1.2.0	**Weight of equipment**		
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 equipment under this specification	*	
1.3.0	**Design, fabrication and testing of the crane confirm to standard / code number**	Mechanical and Electrical as per IS: 3177-2006 & Structure design in accordance to IS 807:2006.	
1.4.0	**Number of crane/s**	Two. nos	One no.
1.5..0	**Crane classification**	M3 (Mechanical and Electrical) as per IS: 807-2006 and 13834 (part-5)-1993	
1.6.0	**Suitable for outdoor or indoor duty**	Indoor	

1.7.0	**Capacity (T)**		
1.7.1	**Main hoist**		
	Rated SWL – tones	150T	150T
	Test load SWL – tones	Rated SWC and over load test : 125% of SWC	
1.7.2	**Aux. Hoists**		
	Rated SWL – tones	50	50
	Test load SWL – tones	Rated SWC and over load test : 125% of SWC	
1.8.0	**Span**	As per Annexure IX: Crane clearance diagram	
1.9.0	**Lifting beam**	Yes	N. A.
1.10.0	**Operation from**	Operator's Cabin+ pendant push button+ Radio Remote Control	Operator's Cabin+ pendant push button
2.0.0	**CRANE PERFORMANCE**		
2.1.0	Crane speed with full load (mtrs/min.)	For Power House area crane	For Butterfly valve House area
	Main Hoist	Refer Clause no. 22.2.3.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification	
	Aux. Hoist		
	Crab travelling speed (CT motion)		
	Crane travelling speed (LT motion)		
	Creep speed M/Min	@ 10% of main speed for all the motions through VVVF drive	
2.2.0	Acceleration values	LT motion (bridge travel)	CT motion (Trolley travel)
		As per IS: 3177	As per IS: 3177
2.3.0	**Lift in Meters**		
	Main Hoist	As per Annexure IX: Crane clearance diagram	
	Aux Hoist	As per Annexure IX: Crane clearance diagram	
2.4.0	**Hook Approaches**	As per Annexure IX: Crane clearance diagram	
2.5.0	**Hand rail pipes**	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)	
3.0.0	**COMPONENT DETAILS**		
3.1.0	**Trolley**		
a.	Type	Fabricated	
b.	Method of fabrication	Fusion welded	
c.	Material conforming to IS:	Mild Steel (Fe410) Gr-B IS: 2062 100% killed, normalized & Ultrasonically tested	
d.	Centre to center distance of wheels (on the same rails)	*	
e.	Whether jacking pads for lifting trolley provided or not	Yes	
3.2.0	**Rope drums**	**Main hoist**	**Aux. Hoist**
a.	Dimensions in mm length and diameter (PCD)	*	*
b.	Material (Indicate IS)	Seamless pipe ASTM -106 or fabricated Fe410w IS: 2062 Gr A/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 machined grooves	
g.	Diameter on bottom of grooves	*	*
3.3.0	**Rope details**		
a.	Standard	IS:2266	
b.	Construction	Extra flexible plough steel / 6 x 19 or 6x37 construction	
c.	Grade	*	
d.	Diameter in mm	*	

e.	Breaking strength	*			
f.	Factor of safety	6			
g.	Type of core	Refer Clause no. 22.3.5.19 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
h.	Number of falls	*			
i.	Length of rope	*			
3.4.0	**Sheaves details**				
a.	Material	Fe 410 WA IS: 2062 Gr. A or B / CS Gr. 280-520 IS: 1030 Design as per IS: 3177- 1999			
b.	Diameter of main sheaves in mm on Root	*			
c.	Diameter of Equalizing sheaves in mm on Root	Should not be less than 62% of calculated main sheave diameter.			
d.	Type of guards provided	Fabricated from rolled steel plate			
3.5.0	**Coupling & Shafting**				
3.5.1	**Coupling details (between motor and gear box)**	**Main Hoist**	**Aux. Hoist**	**Cross Travel**	**Long Travel**
a.	Type	Flexible shock absorbing coupling excepting pin bush 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 (gear box and wheels)**	**Cross Travel**		**Long Travel**	
a.	Type	Flexible geared type			
b.	Size and Torque rating	*			
c.	Guards and Enclosures	Provided			

3.5.3	**Coupling details (gear box and rope drum)**	**Main Hoist**		**Aux. Hoist**	
a.	Type	One of the following arrangements will be adopted for connecting the rope drum with the gear- box. 1. Flexible joint, incorporating flexible geared coupling housed within the drum. 2. Fully flexible geared coupling between the drum & gearbox.			
b.	Size	*			
c.	Guards and Enclosures	Provided			
3.5.4	**Shafting (Output)**				
a.	Diameter in mm	*			
b.	Factor of Safety	As per IS : 3177 (latest edition)			
c.	Number of support bearings	*			
d.	Type of support bearing	*			
e.	Arrangement of Lubrication	Grease cups/ Nipples			
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 M3 duty			
c.	Total no. of reductions	*			
d.	Type of gears	Helical / Spur	NA (Through VVVF drive)	Helical / Spur	NA (Through VVVF drive)
e.	Reduction Ratio	*			
f.	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication			
g.	Hardness (BHN)- Gear	217-255			

h.	Hardness (BHN) - pinion	266-300			
i.	Difference in Gear and pinion hardness	Min 20 BHN			
j.	Material (gear/pinions)	Main Gears En 9/ 55C8/ IS2707 Gr. 1 or 2 Pinions En 19/EN 24 Hardness conforming to IS: 3177 (latest edition) Gears to be hardened, tempered & heat treated as per IS 4460			
k.	Casings	Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved			
l.	Noise Level	85db			
m.	Standard conforming to	IS 4460 / AGMA			
3.6.2	**Travel Motions**	CT	CT micro	LT	LT micro
a.	Type of mounting of gear box	Horizontal / Vertical	NA	Vertical/ Horizontal	NA
b.	Classification	Suitable for M3 duty			
c.	Total no. of reductions	*			
d.	Type of gears	Helical / Spur	NA.	Helical / Spur	N.A.
e.	Reduction Ratio	*			
f.	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication			
g.	Hardness (BHN)- Gear	217-255			
h.	Hardness (BHN) - pinion	266-300			
i.	Difference in Gear and pinion hardness	Min 20 BHN			
j.	Material (gear/pinions)	Main Gears En 9/ 55C8/ IS2707 Gr. 1 or 2 Pinions En 19/EN 24 Hardness conforming to IS: 3177 (latest edition) Gears to be hardened, tempered & heat treated as per IS 4460			
k.	Casings	Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved			
l.	Noise Level	85db			
m.	Standard	IS 4460 / AGMA			

	conforming to		
3.7.0	**Wheels details**	**Cross travel**	**Long travel**
a.	Material	C55 Mn75	
b.	Hardness	300 – 350 BHN	
c.	Difference in wheels and rails	Min 50 BHN	
d.	Depth of hardness	10 (min.)	
e.	Tread Diameter (mm)	*	
f.	Tread width (mm)	*	
g.	Process of hardening	Volume Hardening	
h.	Type	Double flanged	
i.	Numbers Provided	4	16
j.	Specification conforming to	IS: 3177 (latest edition)	
k	Arrangement of lubrication	Grease	
3.8.0	**Lifting hooks**		
		MH	**AH**
a.	Type	Ram shorn, shank with safety latch swiveling type as per latest edition of IS: 5749	
b.	Safe lifting capacity	150T	50T
c.	Material	➢ Class 2 as per IS 1875:1992 (re affirmed 2004) for hooks conforming to IS : 5749 ➢ Class 1A or class 3 for hook of grades L & M respectively as per IS 1875:1992 for hooks conforming to IS : 15560	
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 50% of the rated speed.	
b.	Numbers provided	4	4
c.	Details of end stop	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.	
3.10.0	**Brakes**	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification	
3.10.1	**Hoist Motions**	**POWER HOUSE CRANE**	**BUTTERFLY VALVE HOUSE CRANE**
a.	Type of brake	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification	
b.	Diameter of brake	*	
c.	Torque rating	*	
d.	Number provided per motor	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification	
e.	Braking capacity		
f.	Braking torque actually required	*	
g.	Material		
i.	Brake Liner	Ferrodo liners	
ii.	Drum	CS IS : 1030 / CL 4 IS : 1875	
iii.	Springs	As per manufacturers standard	
h.	Braking Distance in mm	*	
3.10.2	**Travel Motions**	CT	LT
a.	Type of brake	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification	
b.	Diameter of brake	*	

c.	Torque rating	*
d.	Number provided	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
e.	Braking capacity	
f.	Braking torque actually required	*
g.	Material	
i.	Brake Liner	Ferrodo liners
ii.	Drum	CS IS : 1030 / CL 4 IS : 1875
iii.	Springs	As per manufacturers standard
h.	Braking Distance in mm	*
	Storm brake	2 No's LT Rail Clamps (storm brake) shall be provided (FOR POWER HOUSE CRANE ONLY)
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**	
a.	Type	Antifriction ball / roller bearings
b.	Numbers provided for each	As per assembly requirements
c.	Method of lubrication	Refer Clause no. 22.2.5.8 and 22.3.5.15 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
d.	Bearing life	
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. Refer Clause no. 22.2.4.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
b.	Size	*

c.	Vertical Deflection	As per IS 807
d.	Type of connection to end carriage	By fitted bolts
e.	Length	*
f.	Width	*
3.14.0	**Rails**	
a.	Type / section	Refer Clause no. 22.3.9.1 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
b.	Standard conforming to	IS: 3443
c.	Weight per meter	*
d.	Material	50C12 or 55C11
e.	Top width in mm	*
f.	Height in mm	*
g	**Seismic Requirements**	Each crane truck shall have 2 sets of rail clamps, and the trolley shall have 2 sets of automatic rail clamps for each crane girder rail. The rail clamps shall secure the crane bridge and the trolley against upward motion caused by seismic forces. Each clamp shall have a prong under each side of the railhead. Similar rail clamps shall be provided on all monorail trolleys to withstand seismic forces. For more details, Please refer Clause no. 22.3.4.7 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
3.15.0	**Type of platform required on the bridge**	Chequered plate platform 6mm thick over plain as per IS : 3502
a.	Length	Full span length
b.	Walkways	Refer Clause no. 22.2.4.6.b and 22.3.4.6 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
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	By Staircase

	bridges walkway				
f.	Provided at both ends	Yes			
3.16.0	**Motors**	Suitable for ambient temperature of 40 ^{0} C			
10.1	**Hoist Motions**	**MH**	**MH micro**	**AH**	**AH micro**
a.	Type	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification. In addition to this clause Motors should be suitable for Inverter duty.	NA	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification. . In addition to this clause Motors should be suitable for Inverter duty.	NA
b.	Enclosure	TEFC	NA	TEFC	NA
c.	Numbers furnished	1	NA	1	NA
d.	Voltage, phase and frequency	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
e.	Class of protection				
f.	Rated capacity (KW)	The motor shall be suitable for 150 starts / hr and 40% CDF. Motor nameplate rating at 40^0 C shall have Motor rating will be calculated keeping margin of at least 15% over the maximum power requirement in the duty condition specified.			
g.	Rating	S4, 40 % CDF			
h.	Class of insulation	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
i.	Number of starts/ hour	150 starts / hr			
j.	Pull out torque	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
k.	Space heater requirement				
l.	Speed	*			
m.	Contactors for	*			

	motors				
10.2	**Travel Motions**	**CT**	**CT micro**	**LT**	**LT micro**
a.	Type	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification. . In addition to this clause Motors should be suitable for Inverter duty.	NA	Refer Clause no. 22.2.6.2 of section 22-Technical specification of EOT crane, Section C1B-Customer specification. In addition to this clause Motors should be suitable for Inverter duty.	NA
b.	Enclosure	TEFC	NA	TEFC	NA
c.	Numbers furnished	2	NA	2	NA
d.	Voltage, phase and frequency	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
e.	Class of protection				
f.	Rated capacity (KW)	The motor shall be suitable for 150 starts / hr and 40% CDF. Motor nameplate rating at 40^0 C shall have Motor rating will be calculated keeping margin of at least 15% over the maximum power requirement in the duty condition specified.			
g.	Rating	S4, 40 % CDF			
h.	Class of insulation	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
i.	Number of starts/ hour	150 starts / hr			
j.	Space heater requirement	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
k.	Pull out torque				
l.	Speed	*			
m.	Contactors for motors	*			
3.17.0	**Limit switches**	**Main hoist**	**Aux. Hoist**	**Cross Travel**	**Long Travel**
a.	Type	Refer Clause no. 22.2.6.2.b and 22.3.6.3.d of section 22- Technical			

b.	Number provided	specification of EOT crane, Section C1B-Customer specification			
c.	Rating of contacts	*			
d.	Material of contacts	Double break Silver Cadmium			
e.	Control voltage/ Enclosure	110 V/ IP 55			
3.18.0	**Power conductors (DSL)**	Refer Clause no. 22.3.8.3 of section 22- Technical specification of EOT crane, Section C1B-Customer specification			
a.	Type	LT: PVC shrouded Copper conductor bus bar CT : Flexible trailing cable mounting on retracting support (Festoon type)			
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.	Material	*			
d.	Number	*			
e.	Length	Suitable for entire bay length			
f.	Guard provided	Yes			
3.19.0	**Protective & Control panel**				
	Make	OEM			
	Size	*			
	Material	14 SWG, CRCA sheet steel.			
	Numbers and location	One no. Protective panel & One no. each for MH, AH, CT and LT located on bridge platform			
	Degree of Protection	IP 54			
	Illumination	Internal illumination with florescent lamp			
3.20.0	**Master Controllers (for Power house Crane only**	**Main Hoist**	**Aux Hoist**	**Cross Travel**	**Long Travel**
	Number of steps	5	5	4	4
	Type	VVVF drive motor control			
	Voltage & current rating	415 V/10 A			

	Type	Heavy duty type having DOP IP54. Release of operators' hand from the controls shall stop motion and set brakes automatically.	
	Location	Refer Clause no. 22.3.7.3 of section 22- Technical specification of EOT crane, Section C1B-Customer spécification	
3.21.0	**Cable**	**Power**	**Control**
	Material	Refer Clause no. 10.24.3.1, 10.24.4.1 and 10.24.11.1 of section 10-Technical specification of AC & DC POWER CABLES, CONTROL & INSTRUMENTATION CABLES, CABLE RACKS, SUPPORTS TRAYS & ACCESSORIES of Section C2-Electrical specification	
	Size		
	Type		
	Voltage grade	1100 V	
	Voltage drop	Cable from MCC board to motor terminal shall be so sized that the voltage drop does not exceed 5% of rated voltage.	
	Note:-	1. Permanent Cable from MCC board to Power House crane Isolator switch shall be in Vendor's scope. Approximate distance between Power House crane isolator switch and MCC board shall be 110 m. 2. Permanent Cable from MCC board to Butterfly valve crane Isolator switch shall be in Vendor's scope. Approximate distance between Butterfly valve crane isolator switch and MCC board shall be 50 m.	
3.22.0	**Earthing**		
a.	Material of earthing	GI / Copper	
b.	Earthing as per specification	Yes, Refer Clause no. 22.3.8.8 of section 22- Technical specification of EOT crane, Section C1B-Customer specification	
3.23.0	**Contactors**	AC 4 duty for reversing application. AC 3 duty for non-reversing application	
a.	Switches	AC 23 for motor application, AC 22 for other application.	
b.	Fuses	HRC	
c.	Overload relay	Not applicable as the motor overloading condition is controlled by VVVF drive	
3.24.0	**Fire Extinguisher**	POWER HOUSE CRANE	BUTTERFLY VALVE HOUSE CRANE
a.	Type and size	4.5 kg , CO_2 type	
b.	Numbers & Location	One no. in Cabin and Two on bridge	One no. in Cabin and Two on bridge
3.25.0	**Power Supply**	415 V, 3 phase, 4 wire supply at operating floor at centre of bay length	

		with change over switch.	
a.	No. of conductors for LT motion	3 nos.	
3.26.0	**Transformer**		
a.	Quantity	2 X 100 % - 415/110V (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	
d.	Operation	Stand-by control transformer should be able to come in to operation in case of failure of working transformer	
3.27.0	**Illumination**	POWER HOUSE CRANE	BUTTERFLY VALVE HOUSE CRANE
a.	In Cabin	Refer Clause no. 22.3.8.7 of section 22- Technical specification of EOT crane, Section C1B-Customer specification.	
b.	Over Bridge		
c.	Under bridge (250W HBSV lamps) – Nos.		
d.	For inspection of crane components		
e.	Hand lamp socket and hand tool sockets		
3.28.0	**Operators Cabin**		
a.	Type of construction	Closed type, Refer Clause no. 22.2.3.11 & 22.2.4.6 of section 22- Technical specification of EOT crane, Section C1B-Customer specification.	
b.	Area and minimum clear height	2500x1850 mm with a head room of 2000 mm	
c.	Operator's seat	Revolving type	
d.	Warning gong	A foot operated type-warning gong, double bell type suitable for 240V AC, of noise level 95db at 3.5m, suspended outside the cabin with control inside the cabin will be provided and an additional 300 mm dia hand operated metal gong	
e.	Position of controllers	In front/ side of operator's chair	
f.	Ventilation	1 no. fan	

3.29.0	**Type of control for Hoists/ CT/LT operation**	Through VVVF drive
a.	Speed control	Thru' VVVF with minimum 6 pulse design
b.	Starting torque of VVVF	Up to 200 % typical with encoder
c.	Starting current	Less than 150 % of rated torque.
d.	Temperature	VVVF system shall be capable of withstanding up to 50 ° C without derating
28.0	**Sweep**	Sweep shall be attached to the end carriages and to the trolley to remove foreign materials from the rails.
29.0	**Painting & Color Coding**	As per Annexure IV: PAINTING SPECIFICATION
30.0	**Main Isolating switch**	At the center of bay-length
31.0	**Isolation Switch for maintenance**	Two nos. isolating switch shall be provided at extreme ends of the bay length, at a distance of approximately 20 mtrs. from the centre line of first & last column for maintenance of the crane
32.0	**Additional features in operator's cabin and on pendant push button**	-Emergency Push Button (one in cabin, two nos. on bridge platform with easy reach and one on pendant control) -Switches for lights and bells -Lamps for Power 'ON' indication and emergency corner switch operation
33.0	**Load cell**	Refer Clause no. 22.2.6.3 of section 22- Technical specification of EOT crane, Section C1B-Customer specification. Further Digital display monitoring device on front side of each EOT crane to be provided.
34.0	**Electric Hoist (to be erected on monorail beam welded underneath one bridge girder of each Power House crane)**	
a.	Quantity	One number for each Power House EOT crane (Total 2 nos.)
b.	Type	Electric wire rope hoist
d	Capacity	10T
e	Hook approach	As per Annexure IX: Crane clearance diagram
f	Lift	As per Annexure IX: Crane clearance diagram

g	Type of service	Indoor/outdoor to be informed on project to project basis.
h	Overload test	125% of SWL
i	General Design & duty	As per IS: 3938 latest conforming to Class-II
j	Speed with full load (mtrs/min)	
	Creep speed M/Min	@ 10% of main speed for all the motions through VVVF drive
	Hoisting speed	Refer Clause no. 22.2.3.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification.
	Trolley motion	
k	Type of transmission	Through Electric motor and gearbox
l.	Wire Rope	
	Construction / core	Refer Clause no. 22.3.5.19 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
	Code	IS:2266
	Number of falls	Min. 4
m	Factor of safety	Not less than 5
n	Load Hook and block	NORMALISED HOOK ONLY
	Type of load hook	Shank type swiveling with safety latch
	Load hook Code	IS: 15560
	Load hook Material	As per IS: 1875, minimum Class 3
	Hook suspension	Thrust bearing
	Material of block suspension	Fabricated from steel plate, Material: IS: 2062 grade A or B
o	Gear & pinion	
	Type	Spur / Helical
	Material	Gear: 16 Mn Cr 5 / 20 Mn Cr 5 / C40 / C50 / EN19 / EN24 / SAE 8620 / 16 Cr Ni 4 / 18 Ni Cr Mo5 / 39 Ni Cr. MO3 / 42 Cr MO4
p	Lubrication	Oil splash / grease lubricated
q	Bearing type	Antifriction Ball / Roller
r	Trolley drive	

	Wheel	Single flange taper tread
	Wheel conform to (Std. / code)	IS: 3938
	Wheel material	Cast, forged or rolled steel.
	Bearing type	Antifriction Ball / Roller
	Trolley type	Adjustable type to accommodate different beams flange width.
	Hardness	200 BHN (max)
s	SHEAVE	
	Material	Fabricated from steel plate. IS: 2062 Gr. A or B / as per IS: 3938
	Bearing type	Antifriction Ball / Roller
t	BRAKE (HOIST)	
	Type	DC EM (disc/shoe type- fail to safe)
	Capacity	150 % of FLT
	Number	One number for each motor.
u	BRAKE (TROLLEY)	
	Type	DC EM (disc/shoe type- fail to safe)
	Capacity	125 % of FLT or 100% of motor torque (Whichever is higher)
	Number	One number for each motor.
	Lubrication	Oil splash/Grease lubrication
v	ROPE DRUM	
	Material	Seamless steel pipe. ASTM A106 Gr A /B / 53 grade B; Fabricated from MS as per IS 2062 Gr A/B.
	Flange / Flangeless	Flanged
	Type of groove	As per manufacturers standard to suit the layout requirement for nearest hook approaches.(Shall be decided during detail engineering)
w	TYPE OF POWER SUPPLY TO HOIST	
	CT travel	Shrouded Bus Bar (Cu/Al/GI) Conductor Type / EPR flexible trailing cable. (To be informed on project to project basis.)
	MOTORS	HOIST TROLLEY
	Type	Sq. Cage induction, TEFC, S4 duty, 40% CDF

	Number of start	150/300 starts / hr
	Voltage , Phase and Frequency	415V + 10%, 3 phase, 50 Hz, 3 wire/ 4 wire shall be informed during detail engineering.
	Class of insulation	Class “F” and temperature rise limited to class “B” / 700 C whichever is lower.
	Type of enclosure	TEFC
	Degree of protection provided for enclosure	IP-55
	Margin	The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency.
x	LIMIT SWITCHES	Hoisting / lowering Trolley
	Type	----Snap action, self actuating type / two/one way lever ---------
y	Pendent Push buttons station	Up /down / forward / Reverse push buttons (glow type). Indicative marking for easy operation shall be provided. 1.Suitable for IP 55 protection 2.Ambient temp (-25 to 60 deg C) 3.Suitable for upto: 1.5 X 14C cable entry. 4.Pendant shall be multicore EPR flexible. 5.PVC coated steel wire rope for pendant shall be 2 mm.)
z	Control for motions	
	Speed Control	Thru’ VVVF with minimum 6 pulse design
	Starting torque of VVVF	Upto 200% typical
	Starting current	Less than 150 % of rated torque

Note: Other requirements for the system.

- Please refer section 22- Technical specification of EOT crane, Section C1B-Customer specification for other requirements of cranes.
- Centralized grease lubrication with hand operated grease pump for all bearings.
- The crane electrical shall be designed for ambient air temperature of 40 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.
- DSL phase indicating lamps to be provided.

- Two nos. fail safe LT storm/parking brakes, truck end mounted, hydraulic rail clamp type of adequate capacity (depending on wind pressure) to be provided for Power House crane. The setting shall include automatic engagement of clamps in case of crane is left idle for five minutes (adjustable).

- The following parameters shall be considered for design and selection of LT storm /parking brakes.
  a) The basic wind speed “Vb” at ten metres above the mean ground level: 39 meters /second
  b) The risk coefficient “K1” 1.07
  c) Category of terrain Category-2
  d) Other factors in line with IS 875.

- Temporary cables shall not be used as Permanent cables.

TECHNICAL DATA SHEET FOR SINGLE GIRDER EOT CRANE FOR GIS HALL AREA

S.N.	Description	Technical Particulars
1.0.0	GENERAL	
1.1.0	Name of Manufacturer	
	a) EOT Crane	*
	b) Runway conductors	*
1.2.0	WEIGHT OF EQUIPMENTS	
	a) Crane weight (Kgs.)*	*
	b) Weight of DSL (Kgs.)*	*
1.3.0	Design, fabrication and testing of crane conform to standard / code	IS-3177 & 807 (latest edition)
1.4.0	Number of cranes	One (1) 12T no. in GIS HALL
1.5.0	Crane Classification	Group M3 of IS: 3177 – 1999(latest edition) for structure and machinery.
1.6.0	Type of service	----------Indoor----------
1.7.0	Type of Crane	EOT
1.8.0	Capacity (SWC)	12T- GIS Hall Area
1.9.0	Span and lift	As per Annexure IX: Crane clearance diagram
1.10.0	Load test	As per IS: 3177
1.11.0	Over Load Test	(125% of rated capacity-SWC)
1.12.0	Crane structure	Fabricated from rolled section (Box section/ I-section)
1.13.0	Design ambient temperature	40^0 C
1.14.0	Runway Rail	LBS 30 or equivalent. Fixing arrangement (i.e required sole plate, anchor bolt etc.) also shall be in vendor scope.
1.15.0	End carriage	
1.15.1	Material	M.S. as per IS: 2062, GR B
1.16.0	Main girder	
1.16.1	Type & Size	Fabricated from rolled section (Box section/ I-section) Refer Clause no. 22.2.4.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
1.16.2	Material	M.S. as per IS: 2062, GR B
1.17.0	**Power supply**	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
1.18.0	Control Supply	110V (Shall be arranged by vendor)
2.0.0	**CRANE PERFORMANCE**	
2.1.0	**Operation**	Electrical -- From floor by means of Pendant Push Button controller suspended from panel
2.2.0	**Crane speed with full load**	
	a) Hoist (Full speed)	Refer Clause no. 22.2.3.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification
	b) Cross travel (CT)	
	c) Longitudinal bridge travel(LT)	
2.3.0	**Hoisting Mechanism**	Gear
2.4.0	**Type of power transmission**	Gear
2.5.0	**WIRE ROPE**	
2.5.1	Make	As per Sub-vendor list
2.5.2	Core / Construction	Refer Clause no. 22.3.5.19 of section 22- Technical specification of EOT crane, Section C1B-Customer specification

2.5.3	Wire rope dia. (mm)	*		
2.5.4	Wire rope fall	*		
2.5.5	Material	Plough steel		
2.5.6	Tensile strength	160-180 Kg /mm^2		
2.5.7	Min. Breaking load	*		
2.5.8	Conform to (Std. / code)	IS-2266		
2.6.0	**LOAD HOOK / HOOK BLOCK**			
2.6.1	Make	As per sub-vendor list		
2.6.2	Type of load hook	Plain shank, Trapezoidal section-forged as per IS: 15560, with safety latch.		
2.6.3	Material of load hook	Forged steel		
2.6.4	Type of Bearing of hook suspension	Thrust ball bearing		
2.6.5	Make of Bearing of hook suspension	*		
2.6.6	Type and Material of hook suspension.	M.S. Fabricated		
2.7.0	**ELECTRIC HOIST**			
2.7.1	Model No.	*		
2.7.2	Duty	Class II (M3) as per IS: 3938 (latest edition)		
2.8.0	Type of DSL			
2.8.1	Long travel	PVC shrouded bus bar conductor type		
2.8.2	Cross traverse	Flexible cable with Taut wire / Festoon cable arrangement		
2.9.0	**MOTORS**	M.H.	C.T.	L.T.
2.9.1	Make	As per sub-vendor list		
2.9.2	Rating (KW)	*		
2.9.3	RPM	*		
2.9.4	Qty.	1	2	2
2.9.5	Minimum number of poles	6	6	6
2.9.6	Type	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B- Customer specification. . In addition to this clause TEFC, S4 duty, 40%CDF		
2.9.7	Enclosure	IP-55		
2.9.8	Number of start	150 starts/Hr.		
2.9.9	Insulation	70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.		
2.9.10	Margin	Maximum continuous motor ratings shall be 15% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.		
2.9.11	Over load protection provided	YES		
2.9.12	Ambient Design temperature	40^{o}C		
2.9.13	Pull out torque for motor	Refer Clause no. 22.2.6.2 of section 22- Technical specification of EOT crane, Section C1B- Customer specification		
2.10.0	**LIMIT SWITCHES**			
2.10.1	Location	M.H.	C.T.	L.T
2.10.2	Qty.	1+1	1	1

2.10.3	Type	Refer Clause no. 22.2.6.2.b and 22.3.6.3.d of section 22- Technical specification of EOT crane, Section C1B-Customer specification		
2.10.4	Method of actuation	Snap action	Shunt type	Shunt type
2.10.5	Material of contact	Silver Cadmium		
2.10.6	Make	As per Sub-vendor list		
2.10.7	Control Voltage	110V		
2.11.0	**Control panel**	A suitable control panel (MOC: 14 SWG, CRCA sheet steel.) will be provided comprising of main contractor, motor contactor, single phase preventor with overload relays, transformer, fuses, MCCB's, etc. Rectifier panel for brake shall also be provided. Internal illumination with florescent lamp shall be provided.		
2.12.0	**BRAKES**	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification		
2.12.1	Location	M.H.	C.T.	L.T.
2.12.2	Qty. / Motor	Refer Clause no. 22.2.5.5 of section 22- Technical specification of EOT crane, Section C1B-Customer specification		
2.12.4	Type			
2.12.5	Capacity			
2.12.6	Size / rating	*		
2.12.7	Make	As per sub-vendor list		
2.13.0	**GEAR (HOISTING)**			
2.13.1	Make	As per sub-vendor list		
2.13.2	Type	Spur / Helical		
2.13.3	Material	Gear: EN8 / 20 Mn Cr / 16 Mn Cr Pinion: EN9		
2.13.4	Lubrication	Grease / Oil splash		
2.13.5	Reduction	*		
2.13.6	Bearing Make	*		
2.13.7	Bearing Type	Antifriction deep groove ball / roller bearing		
2.13.8	Hardness (BHN)	As per IS 3177 (Latest Edition)		
2.14.0	**GEAR (L.T. & C.T.)**			
2.14.1	Location	C.T.	L.T.	
2.14.2	Make	As per sub-vendor list		
2.14.3	Type	Spur / Helical	Spur / Helical	
2.14.4	Material	Gear: EN8 / 20 Mn Cr / 16 Mn Cr Pinion: EN9	Gear: EN8 / 20 Mn Cr / 16 Mn Cr Pinion: EN9	
2.14.5	Lubrication	Grease / Oil splash	Grease / Oil splash	
2.14.6	Reduction	*	*	
2.14.7	Bearing Make	As per sub-vendor list		
2.14.8	Bearing Type	Antifriction deep groove ball / roller bearing	Antifriction deep groove ball / roller bearing	
2.14.9	Hardness (BHN)	As per IS 3177 (Latest Edition)		
2.15.0	**WIRE ROPE DRUM**			
2.15.1	Material	Fabricated from M.S. as per IS: 2062, Gr B and stress relieved or seamless pipe ASTM A106 / 53 Gr B		
2.15.2	Diameter	*		
2.15.3	Length	*		
2.15.4	Type	Flanged		
2.15.5	Type of grooves	*		
2.16.0	**WHEELS**			
2.16.1	Location	C.T.	L.T.	
2.16.2	Diameter (mm)	*	*	
2.16.3	Qty	*	*	

2.16.4	Hardness	200 BHN (Max.)	200 BHN (Max.)
2.16.5	Material	EN8 / EN9	EN8 / EN9
2.16.6	Bearing make		
2.16.7	Bearing Type	Antifriction deep groove ball bearing	Antifriction deep groove ball bearing
2.16.8	Flange	Single flanged	Single flanged
2.16.8.1	Conform to IS	3177	
2.16.8.2	Wheel Base	*	
2.17.0	**SHEEVE**		
2.17.1	Material	Cast steel	
2.17.2	Groove dia/ O.D. .(mm)	*	
2.17.3	Bearing make	As per sub-vendor list	
2.17.4	Bearing Type	Antifriction deep groove ball bearing	
2.18.0	**CONTROL PANEL**	* Fabricated from 14 SWG, CRCA steel sheet min 2 mm thick. * Degree of protection shall be IP 55. * Power on indicating lamps shall be provided * Panel illumination lamps operated by door switch. * 2 nos earthing terminals on panel. * 20 % spares terminals (clip on type) shall be provided. * Power and control terminals (clip on type) shall be on separate channels. * Gland plate thickness shall be minimum 3mm. * Gland plate shall be double brass compression type.	
2.18.1	Qty	One	
2.18.2	Make	As per sub-vendor list	
2.18.3	Location	On the crane	
2.18.4	Size	*	
2.18.5	Thickness of sheet	2 mm	
2.19.0	**ISOLATING SWITCH**		
2.19.1	Qty	One (1) no at 1.5 m from operating floor.	
2.19.2	Make	As per sub-vendor list	
2.19.3	Rating	*	
2.20.0	**PENDANT PUSH BUTTON**	Up /down / forward / Reverse push buttons (glow type). Indicative marking for easy operation shall be provided	
2.21.0	Cables	Power	Control
2.21.1	Make	As per Sub-vendor list	
2.21.2	Material	Power cable and control cable: Refer Clause no. 10.24.3.1, 10.24.4.1 and 10.24.11.1 of section 10-Technical specification of AC & DC POWER CABLES, CONTROL & INSTRUMENTATION CABLES, CABLE RACKS, SUPPORTS TRAYS & ACCESSORIES of Section C2-Electrical spécification Trailing cable: 1.1 kV grade with highly flexible stranded tinned copper conductor, insulation of EPR (Ethylene-propylene Rubber) each individual core protected and covered and overall outer cover of poly-chloroprene rubber cable conforming IS: 9968 (Part-I)-1988.	
2.21.3	Type	*	*

2.21.4	Dearing factor to be considered	YES	YES
2.21.5	Voltage grade	1100V	
2.21.6	Note:	Permanent Cable from MCC board to GIS Hall crane Isolator switch shall be in Vendor's scope. Approximate distance between GIS Hall crane isolator switch and MCC board shall be 50 m.	
2.22.0	**END STOPPER (LT)**		
2.22.1	Qty.	4 Nos.	
2.22.2	Material	As per IS 2062	
2.23.0	**BUFFER**		
2.23.1	Location	CT	LT
2.23.2	Qty	Two	Four
2.23.3	Material	Rubber/Spring	Rubber/Spring
2.24.0	**PAINTING**	Refer painting specification	
2.25.0	**Control for Hoisting operations**	Thru' VVVF drives	
a.	Speed Control	Thru' VVVF with minimum 6 pulse design	
b.	Starting torque of VVVF	Upto 200% typical	
c.	Starting current	Less than 150 % of rated torque	
d.	Temperature	Capable of withstanding upto 40°C without derating	

Note:

- **Bidder to confirm the compliance of technical details as mentioned against each item. Deviation, if any shall be brought out clearly.**
- **The bidder shall fill Technical details against each item marked (*), during detailed engineering only.**
- **In case of discrepancy between the Data sheet and requirement given elsewhere in the technical specification, the more stringent of the two as per the interpretation of purchaser shall be applicable.**

VOLUME - IIB

SECTION – C2

ELECTRICAL SPECIFICATION

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

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 same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Electrical load requirement for **Cranes.**
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, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implication to BHEL.
h) Motor shall meet minimum requirement of motor specification.
i) Cable from supply feeder to isolating switch shall be in Vendor scope.
j) Sub-vendors shall be subjected to final approval by customer at contract stage without any technical / commercial implication to BHEL.

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

3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.

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 :

a) Electrical scope between BHEL & vendor (Annexure –I)
b) Standard BHEL specification for motors.
c) Datasheets (A&C) & quality plan for motors.
d) Electrical Load data format (Annexure –II)
e) Specification for Power cables, cable trays and accessories.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: DOUBLE GRIDER EOT CRANES (for Power House crane and Butterfly Valve area Crane)

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

PROJECT : 4 x 111 MW VISHNUGAD PIPALKOTI HEP

S. NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 4W) supply feeder only. 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	Vendor	Vendor	Cable from supply feeder to isolating switch shall also be in Vendor 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 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing & cable routing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

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

PACKAGE: SINGLE GIRDER EOT CRANES & ELECTRIC HOISTS (For GIS Hall Area crane)

SCOPE OF VENDOR: SUPPLY

PROJECT : 4 x 111 MW VISHNUGAD PIPALKOTI HEP

S. NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 4W) supply feeder only up to isolating switches for cranes/ hoists. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane/ hoist 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 also be in Vendor 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 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing & cable routing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

SECTION – 10

TECHNICAL SPECIFICATIONS FOR AC & DC POWER CABLES, CONTROL & INSTRUMENTATION CABLES, CABLE RACKS, SUPPORTS, TRAYS & ACCESSORIES

10.1 SCOPE OF WORK

10.1.1 This section of specification covers complete design, engineering, manufacture, assembly, testing at works before dispatch, packing, forwarding, transportation, insurance, storage & preservation at project site, erection, testing & commissioning and remedial action, if any upto defects liability period of AC & DC Power & control cables, cable racks, trays, supports, cable lugs, glands and all other accessories as detailed hereinafter in this specification for Vishnugad Pipalkoti HEP. The scope of work also covers laying of power cables and other cables as detailed herein after in this specification on cable trays and in ground as required, their termination on various panels, marshalling boxes, equipment etc. in power house complex comprising underground machine hall and transformer hall caverns, various tunnels, pothead yard, BFV,GIS and GIB cavern, spherical Valve, Main Inlet (MIV) Chamber, service building at MAT portal, Control rooms at surge shaft, TRT outlet, Dam site & Desiltation chambers etc. The bidder shall also fabricate the support structures with sufficient free space of about 10% for cable racks & trays either at his works or at site and install them at various locations of the project as per approved drawings.

10.1.2 Civil works relating to cable facilities i.e. cable galleries /tunnel, cable trenches/ducts etc. are excluded from the scope of this specification. However, minor civil works like fixing of anchor bolts, breaking of wall/floor for putting conduits/pipes and sealing of wall/floor/shaft opening shall be within the scope of this specification.

10.1.3 The scope of work also includes erection, testing and commissioning of all the laid cables. Detailed engineering of the work involved is also covered in the scope of the Contract to the extent specified in these Technical Specifications.

10.1.4 All tests are to be carried out by the bidder in accordance with applicable standards. Any defect noticed during test or during the guarantee period is to be rectified by the bidder free of cost.

10.1.5 The bidder, when ordered in writing by the purchaser shall perform extra work not covered by the specifications or not included in the schedule, but forming an inseparable part of the contracted work.

10.1.6 In addition to the above, the bidders shall offer all other works incidental to and connected with the above services from delivery up to handing over of the equipment after successful commissioning.

10.1.7 The scope of the present Technical Specification shall also include supply, erection of cable racks, trays, conduits, supports and all other accessories for the power and control cables covered under these Technical Specifications and spread in the following areas:

- Underground power house caverns (M/c hall cavern and Tr. Hall cavern)
- Various tunnels and access-adits
- Service building near MAT portal.
- Control rooms at Dam site, Desiltation chambers, pothead yard, BFV chambers, Surge shaft top & TRT outfall etc.

10.1.8 Cable supporting structures, trays and racks shall also have sufficient free space (about 10%) for laying a few cables supplied by others.

10.2.3 Control & Instrumentation cables (0.65/1.1 kV)

The control and instrumentation cables are required for interconnection between control panels of various systems of the VPHEP structures and for some systems as detailed herein after.

10.3 STANDARDS

All materials/equipment used in manufacturing the cables and associated accessories shall comply with applicable provisions of the latest editions of relevant International Standards, Bureau of Indian Standards, Indian Electricity Rules, Indian Electricity Act and other applicable statutory provisions in regulations. The cables and accessories stipulated in this specification shall conform to the latest applicable provisions of the following standards:

1)	IS:1554 (Part-I&II)	PVC insulated (Heavy duty) electrical cables for working voltages up to and including 11000 V
2)	IS:7098	Cross-linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV up to and including 33 kV
3)	IS:3961	Recommended current ratings for cables
4)	IS:8130	Conductors for insulated electric cables and flexible cords
5)	IS:5831	PVC insulation and sheath of electric cables
6)	IS:1753	Aluminium conductors for insulated cables
7)	IS:2982	Copper conductors for insulated cables and cords
8)	IS:3975	Mild steel wires, strips and tapes for armouring cables
9)	NEMA WC-5	Thermoplastic insulated wires & cables for transmission and distribution of electric energy
10)	ASTMD-2863	Method for measuring minimum oxygen concentration to support candle-like combustion of plastic
11)	IEEE 383/	Standard for type test of electric cables
12)	SEVENSK STD. 4241475	Flammability tests for cables
13)	ASTMS 2743	Test method for density of smoke from the burning or decomposition of plastics

14)	IEC-60183	Guide to the selection of high voltage cables
15)	IEC- 60227	Polyvinyl chloride (PVC) insulated cables of rated voltages up to and including 450/750 V
16)	IEC-60228	Conductors of insulated cables
17)	IEC-60229	Tests of cable oversheaths which have a special protective function and are applied by extrusion
18)	IEC-60230	Impulse tests of cable and their accessories
19)	IEC-60287	Calculation of the continuous current rating of cables (at 100% load)
20)	IEC-60331	Fire resisting characteristics of electric cables
21)	IEC-60332, Part-I, II & III	Tests on electric cables under fire conditions
22)	IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV
23)	IEC-60540 &60540A	Test methods for insulation and sheaths of electric cables and cords (elastomeric and thermoplastic compounds)
24)	IEC-60724	Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0.6/1 kV
25)	IEC-60754	Test on gases evolved during combustion of electric cables
26)	IEC-60811	Common test methods for insulating and sheathing materials of electric cables
27)	IS: 60226	Specification for structural steel
28)	IS: 816	Code of practice for use of metal arc welding for general construction in mild steel.
29)	IS: 4759	Hot dip zinc coating on structural steel and other allied products.
30)	IS: 2629	Recommended practice for hot dip galvanizing of iron/steel
31)	IS: 1239 (Part-I)	Mild steel tubes and iron fittings
32)	IS: 3480	Specification for flexible steel conduits for electrical wiring
33)	IS: 3043	Code of practice for earthing
34)	IS: 3837	Specification of accessories for rigid steel conduit for electrical wiring.
35)	IS: 1653	Rigid steel conduits for electrical wiring.
36)	IS: 2667	Fittings for rigid steel conduits for electrical wiring.
37)	IS:10810	Testing of cables
38)	IS : 1255	Installation & Maintenance of cables
39)	IS:5578	Guide for marking of insulated conductors
40)	IS:11353	Guide for uniform system of marking & identification of Conductors
41)	IS : 1893	Earthquake resistant design
42)	IS:2062	Steel for general structural purposes
43)	ANSI / IEEE-80	Earthing of the equipment

44)	IS:5608	Specification for low frequency wires and cables with PVC insulation and PVC Sheath
45)	IS:800	Code of practice for use of structural steel in general building construction

10.5 SERVICE CONDITONS FOR CABLES AND ACCESSORIES

10.5.1 The cables shall be heavy duty type and suitable for continuous operation under climatic conditions prevailing at the site - hot humid tropical climate.

10.5.2 The supporting structure shall be designed for operation in seismic zone-V (as defined in latest edition of IS: 1893- Criteria of

Earthquake Resistance Design of Structures) which is prone to severe earthquakes. The supporting structure shall be strong enough to resist total operating stresses resulting from the forces in normal operation and in abnormal condition (due to short circuit) with forces superimposed due to occurrence of earthquake. Dampers and or additional supporting structures may be provided with the equipment, if necessary to their operation in the seismic zone. A horizontal seismic coefficient $\propto_h$=0.1675 and vertical seismic coefficient $\propto_v$=0.1 shall be considered for calculations of seismic forces acting on the equipment during earthquakes.

10.5.3 The cables shall have a termite , vermin , rodent-proof covering. The outer sheath of these cables shall be fire/ flame-retardant, low smoke (FRLS) and heat shrinkable type. The inner insulation of these cables shall be heat resistant (HR) type.

10.5.4 All 11 kV AC power cables shall have multicore aluminum conductor & XLPE insulation and all AC/DC power cables of 415 V & 220V rating (having multi core/single core aluminum /copper conductors) shall have PVC type of insulation.

10.5.5 The cables for outdoor installation where mechanical damages are possible, should be of armoured type. The armouring should be applied for cables over the inner sheath. It can be of steel strips/tapes/ round wires and shall conform to IS: 3975.

10.5.6 The cables shall be capable of satisfactory operation under a power supply system comprising of frequency variation of +/-5% ,voltage variation of +/-10% and a combined frequency & voltage variation of 10% (absolute sum). These shall be of type and design with proven record of power station installation.

10.5.7 All control and instrumentation cables shall be multi core annealed high conductivity copper conductor stranded type, insulated with HR-PVC insulation, PVC Sheathed conforming to IS:1554 (Part I or II) . The outer sheath is of specially formulated PVC compound.

All control cables (except current transformer secondary circuits) shall have atleast 20 % spare cores.

Control cables shall be standardised as much as possible in order to supply only a few different type (e.g. 4, 5, 7, 10, 14, 19, 27)

Control, annunciation, voltage and current transformers secondary wiring shall be 650/1100 V grade, multi-conductor cables, Single conductor cables shall be used for short runs.

For the cables for pick-ups, for data transmission to CCS and elsewhere the flexible cables are necessary, the conductors shall be plain copper, stranded wire type with PVC core insulation.

The cables for analog signals transmission to computers of Computerised Control System shall be 600 V grade screened twisted pair solid multi-conductor of 0.8 millimetre diameter.

The cables for current and voltage transformers secondary wiring, termperature detectors, gauges, alarm circuits, data transmission to Computerised Control System etc. shall have braided screen of tinned Cu or steel wires.

10.6 CABLE CONSTRUCTION DETAILS

The cables shall be multi core/single core XLPE, HR-PVC and special type as specified. All types of cables covered under these technical specifications shall be Fire Retardant Low Smoke type (FRLS).

10.6.1 Conductor

The conductor shall be made from high conductivity annealed tinned copper/aluminium metals (as specified against each type of cable in these specifications & schedule of quantities) to form compact conductor having a resistance within the limits specified in IS:8130.

10.6.2 Conductor Shield / Screen

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the

insulation. The semi-conducting polymer shall be cross-linked (for XLPE Cables).

10.6.3 Insulation

The insulation of the cables shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality.

10.6.4 Insulation Shield / Screen

In XLPE cables, to confine electrical field to the insulation a non-magnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by Triple extrusion process. The XLPE cable insulation shall be strippable. Metallic screening as given in this specification for the various control, power and special cables shall be provided.

10.6.5 Inner Sheath

Application of inner sheath is required in the armoured cables only. The sheath shall be suitable to withstand the site conditions and specified temperature conditions. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality free from any defects. The sheath shall be extruded type.

10.6.6 Armouring

Hard drawn aluminium wire or single galvanised steel tape/ strip shall be used for armouring of single core or multi core cables respectively .The hard drawn aluminium wire for armour shall be H4 grade. The diameter of the aluminium hard drawn wire and thickness of steel tape/strip shall be as per relevant standard.

10.6.7 Outer Sheath

Extruded PE/PVC outer sheath as specified shall be applied over armouring /insulation screen with suitable additives to prevent attack by rodents and termites. Necessary carbon coatings shall be provided over PE insulation (if provided) to make conducting surface for testing purpose.

10.6.8 Fillers

The cable shall have suitable fillers laid up with the conductors, before the sheath is applied and the fillers shall be of substantially circular cross section. Fillers shall be suitable for operating with the temperature of the conductor and compatible with the insulation.

10.7 SIZES & LENGTHS OF CABLES

10.7.1 The number of cores and sizes of the cables required for various circuits shall be as specified in the "Schedule of Requirements", clause 10.25.

10.7.2 The cables covered by these specifications shall be supplied in one length or in standard lengths as approved by the purchaser. Standard length of each type and size of cables shall be indicated in the offer.

10.8 CABLE IDENTIFICATION SCHEME

10.8.1 To facilitate easy identification of phases, a colour scheme of Red, Yellow and Blue for phases and Black for neutral shall be adopted for power cables. Multi-core control cables shall be colour coded for identification of cores as per IS:1554-1976.

10.8.2 Following colour scheme shall be adopted for power cables:

1 – core	Red, Yellow, Blue or Black
2 – core	Red and Black
3 – core	Red, Yellow and Blue
4 – core	Red, Yellow, Blue and Black
5 – core	Red, Yellow, Blue, Black and Green or Light Green

Where the number of cores exceeds 5, two adjacent cores (counting core and direction core) in each layer are coloured Blue and yellow and the remaining cores are Light grey.

Control cables with core identified by numbers can also be provided.

10.8.3 All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least 3 metre run. The manufacturer's data shall include the manufacturer's name, cable size, voltage & current rating, type of insulation together with any other information which the manufacturer considers appropriate. In addition "THDC-VPHEP" shall also be printed at every 3 metre run.

10.9 TESTS AND INSPECTION

10.9.1 General

10.9.1.1 The bidder shall submit a list of testing facilities available in the manufacturer's works at the time of submitting the offer.

10.9.1.2 Authorised representative(s) of purchaser shall have at all reasonable times access to the contractor's/sub-contractor's premises or works to inspect and examine the materials and workmanship of the equipment during its manufacture.

10.9.1.3 All the required tests as per standard/specifications shall be carried out on bidder's expenses. If any component of the equipment fails in the specified tests, the same shall be replaced/rectified and again offered for inspection and testing.

10.9.2 Type Tests & Reports

10.9.2.1 The bidder shall submit following type test reports not older than 5 years in respect of all sizes of the cables as per requirement of latest standard/specification along with the bid for examination. The tests should have been conducted by a recognised test centre like CPRI, other public sectors, Govt. Agencies, etc. which must be acceptable to the purchaser. If the type tests & optional tests are not found satisfactory, the purchaser may ask the supplier for re-

conducting any or all the type tests & optional tests in presence of purchaser's representative without any extra cost.

Requirements of tests for Power & Control cables (IS:1554):

a) Tests on conductor:

i) Measurement of Conductor resistance
ii) Tensile test (for Aluminium conductors only)
iii) Wrapping test (for Aluminium conductors only)
iv) Annealing test (for Cu)

b) Tests for insulation and sheath:

i) Ageing test in air / oven.
ii) Heat Shrinkage/ deformation test.
iii) Loss of mass test in air / oven.
iv) Heat shock test.
v) Thermal stability test.
vi) Measurement of Insulation resistance.
vii) High voltage test (cable immersed in water).
viii) High voltage test at room temperature
ix) Tensile strength and elongation at break of insulation and sheath

c) Tests for armouring wires/strips:

i) Nominal thickness (for steel strip)
ii) Nominal Diameter (for round wire)

10.9.3 Routine Tests (at Manufacturer's Works)

10.9.3.1 Following routine tests shall be conducted by the manufacturer during the manufacturing of equipments and test reports alongwith

description of test results , methodology etc. shall be submitted for purchaser's approval.

a) Annealing test (for Cu).
b) Tensile test (for Al).
c) Wrapping test (for Al).
d) Measurement of conductor resistance
e) Measurement of thickness of insulation and sheath
f) Measurement of tensile strength and elongation at break of insulation and sheath.
g) Insulation resistance measurement
h) High voltage test at room temperature in air (Dielectric test).

10.9.3.2 Following Routine & Optional tests (as per standard) shall be conducted in presence of purchaser. Test reports shall be submitted by the firm and got approved by purchaser before despatch of equipment / material.

a) Conductor resistance measurement (Routine Test)
b) High voltage test at room temperature (Routine Test)
c) Insulation resistance measurement (Routine Test)
d) Cold bend test (Optional)
e) Cold impact test (Optional)
f) Armour resistance measurement (Optional)
g) FRLS test (Optional)

(Under FRLS tests as per IEC-60332, following parameters as detailed below are to be determined in addition to the tests specified in IEC-60332:

i) HCL gas evaluation test (IEC - 754.1).
ii) Oxygen Index (ASTM-D-2863).

iii) Temperature Index (ASTM-D-2863).
iv) Smoke density test (ASTM-D-2863).
v) Flammability test (IEC-332.1).
vi) Swedish Chimney test (SS-424 14 75).

h) As per relevant standards and approved drawings, cable drums shall be inspected visually & dimensionally.

i) XLPE cables shall be tested as per IS: 7098.

j) Any other test specified by relevant IS as necessary for factory acceptance.

10.9.4 Testing & Commissioning at Site

10.9.4.1 The specified power cables shall be commissioned progressively in a phased manner to be decided through mutual consultation between the bidder and the purchaser at the time of the award of the Contract.

10.9.4.2 Bidder shall be fully responsible for correct terminations and if at the time of commissioning some modifications/rectifications are required the same shall be carried out by him free of cost.

10.9.4.3 If any terminations/cable boxes etc. fail at the time of commissioning, the bidder shall be responsible to replace the same free of cost.

10.9.4.4 While testing the cables, damage occurs to any equipment, cables etc. not covered under the scope of this package, due to negligence of the bidder or his representative, shall be sole responsibility of the bidder to replace the same free of cost.

10.9.4.5 The bidder shall carry out the following commissioning tests and checks. In addition, the bidder shall also carry out all other checks and tests which are recommended by the manufacturer.

i) Check for physical damage, if any
ii) IR test (each core to earth & core to core)
iii) Continuity test
iv) Dielectric tests
v) Identification of cores (before & after termination)

10.9.4.6 Test results of the commissioning tests conducted at site shall be submitted to the purchaser within 3 days for approval. After approval has been received, the cables shall be connected to the line terminals.

10.10 SUBMISSION OF DRAWINGS AND TECHNICAL LITERATURES

10.10.1 The bidder shall submit full technical details, descriptive literatures, leaflets and the general drawings of the cables showing details of conductors, insulation, sheaths etc. and technical particulars of cable racks, trays, supports etc. with the bid.

10.10.2 The bidder shall furnish following design drawings for the purchaser's approval after award of contract:

i) General layout arrangement for different sizes of cables trays, racks, supports, conduits etc.
ii) Different type of cable termination lugs, glands and jointing arrangement proposed.
iii) Allocation of Power cables and control cables on different cable racks and trays.
iv) Embedment details of plates, channels and fixing/assembly of cable racks / support system etc.

10.10.3 After the final approval of the above design drawings, all the approved drawings alongwith a set of reproducibles (soft copy in CD form) shall be submitted.

10.10.4 The bidder shall also supply detailed instructions & maintenance manuals for purchaser's references.

10.11 ERECTION OF CABLES, TRAYS, RACKS & SUPPORTS ETC.

10.11.1 General

10.11.1.1 The bidder shall furnish and install all necessary cable trays / racks and cable support systems complete with brackets, supports,

hardware and special fittings for power and control cables , cable trenches & ducts as specified herein or as approved by the purchaser. Special fittings shall include tees, wyes, bends, crosses, dividers, reducers, dropouts, connectors, supports and all other materials required to form a complete cable tray system. Supports shall allow future installation of additional trays, where required , without disturbing the existing installation.

The power & control cables shall run separately on cable racks/trays, in cables /cable tunnels and on columns, walls, ceiling and pulled through pipes

10.11.1.2 The bidder in his design shall give preference to the use of cable trays through out. Where this is not feasible because of space, cable supports may be used, subject to purchaser's approval.

10.11.1.3 The bidder shall supply and be responsible for carrying out proper fixing of the cables at regular intervals with non magnetic cable fixing strips (moulded fibre glass strip/PVC sleeved clamps), fasteners, etc., wherever necessary to hold the cables firmly to the trays.

10.11.1.4 Cushion type cable clamps shall be provided to hold firmly the cables on the steel supports without harming the cable insulation where laying of racks & trays is not feasible.

10.11.1.5 The bidder will submit typical drawings along with Tender giving proposed clamping arrangement and also give distance of clamping at bends and in regular run of cables.

10.11.1.6 Power cables in the power house and other areas shall be laid on the cable racks/ supports installed along the walls & roofs, in cable tunnels, trenches, ducts and shafts etc.

10.11.1.7 The bidder shall bring his own tools & plants such as welding set, cutting torches, crimping tools, wire cutters etc. for undertaking and completing the work. The purchaser shall not supply any material in this regard.

10.11.1.8 The bidder shall also be responsible for receiving & transporting the cables, material for cable racks, trays, supports and other accessories from the project store to the work site.

10.11.2 Cable installation

The following are some of the salient factors which shall be kept in view during installation of XLPE/PVC insulated cables:

i) Before laying, the insulation of the cables shall be checked with megger as a preliminary check against any probable damage. A log book of such meggar value shall be maintained by the bidder.

ii) The drum shall be rolled in the direction of arrow for rolling marked on the drum.

iii) The joints being the weakest point of the electric power transmission system, therefore the prefabricated type of joints shall be preferred otherwise necessary precautions/ instructions of the Manufacturer for making joint at site shall be strictly followed.

iv) Minimum bending radius i.e. 12 times of the overall diameter of the cable shall be maintained.

10.11.3 Cable Termination

10.11.3.1 All cables that will be laid by the bidder shall be terminated at both ends. The bidder shall make all electrical connections strictly in accordance with the purchaser's cable schedule (prepared after detailed engineering showing allocation of cable routes made by the bidder) and shall provide numbered ferrules at each connecting terminal in order to check connections without any difficulty. One termination shall mean connecting both ends of one core of a cable to given terminal blocks. The cables shall be terminated by crimping lugs to the ends..

10.11.3.2 The various auxiliary equipments which are proposed to be installed in Vishnugad Pipalkoti HEP at various floors / locations where cable connections are required have been shown in the enclosed specification drawings.

10.11.4 Erection of Straight through joints

10.11.4.1 Straight through cable joints, wherever required shall be supplied and installed by the bidder. The bidder shall quote unit rates for straight through joints for different size of cables. The supply shall include necessary epoxy resin, jointing ferrules, tapes, plumbing material, etc. required for making the joint complete in every respect.

10.11.4.2 Where the cable is to be jointed with existing cable, the sequence of cores at the two ends to be jointed shall be in the opposite direction, i.e. if at one end it is in clockwise direction, at the other end it shall be in anticlockwise direction. This is necessary to avoid the crossing of cores while jointing.

10.11.4.3 Straight through cable joints for 11kV XLPE cables shall be constructed through proven technique and shall be complete with all accessories. Details of technique proposed to be adopted to install prefabricated joint shall be indicated in the bid.

10.11.4.4 When two or more cables are laid together, joints shall be arranged to be staggered by about 3 meters.

10.11.4.5 For straight through joints epoxy resin should be used. Jointing of cables shall be in accordance with relevant Indian Standards, Codes of Practice and manufacturer's special instruction including epoxy resin. Cables shall be firmly clamped on either side of a straight through joint at not more than 300 mm away from joints. Aluminium identification tags shall be provided at each joint and at all cable terminations. Single core cable joints shall be marked so that phase identity at each joint can be determined easily. The joints shall be located at most suitable places. There shall be sufficient overlap of cables to allow for the removal of cable ends

which may have been damaged. The design of the joint boxes must ensure that the actual insulation strength between phases and earth is greater than that of the associated cable and eliminate any possibility to moisture entering the joint or the compound surrounding the joint. Provision shall exist for bonding the sheaths of the two cables being joined solidly by approved means to ensure electrical continuity of sheath from one end of the cable run to other. Full details of the joint boxes and of the joints including dimensions shall be given by the contractor. The contractor shall take care while jointing the various cables that colour code of both sides should match to avoid confusion at both termination points.

10.11.4.6 Special tools, clips and saddles, glands, seals, PVC sealing compound, lock nut, etc. required for the connection and termination of cables including any special cables shall be supplied by the contractor. Cable shall not be fastened or clamped close to the point of entry of the equipment which may vibrate severely. Special instruction, if any, shall be strictly followed.

10.11.5 Erection of Cable trays, racks and support structures

10.11.5.1 Cable trays shall be fabricated of 14 gauge mild steel sheet of suitable width maximum five hundred (500) millimeters with sixty (60) millimeters sides and having oblong shape slots of 20 mm x 8 mm size throughout its length and height. The trays shall be ladder or perforated type.

10.11.5.2 Prefabricated fittings shall be used for changes in direction, elevation or size and field fabrication shall be limited to cutting straight sections for odd lengths only. Couplings and elbow plates between trays and fittings shall be firm without offset of sharp edges. The racks shall be of ISA 50x50x6 mm.

10.11.5.3 The entire tray and rack system will be electrically continuous & grounded by a GI flat of adequate size at five (5) metre intervals. Conduits joining the tray system will also be grounded there. Steel

trays and fittings shall be hot dip galvanized adequate size after fabrication. Minimum clearance between trays and walls shall be fifty millimeters.

10.11.5.4 Brackets for supporting the trays and racks shall be welded with steel supporting channels anchored to the walls or welded to embedded plates. The cable trays, racks, brackets, support structures shall be fully galvanized as per the relevant IS and the tack welded portion of trays shall be given a layer of epoxy paint or shall be treated with galvanised compound. Supporting structures shall permit position adjustment of trays or racks. All corners shall be as smooth as possible.

10.11.5.5 Required embedments in concrete will be done by others, however, the cable support structures shall be welded to above embedded plates or channels by the bidder . The bidder shall furnish the necessary embedment materials such as rock bolts & embedment plates etc. alongwith the detailed dimensional foundation drawings well in advance so that these can be fixed / embedded wherever required by the civil contractors. However, any additional embedments found necessary during erection/detailed engineering stage shall be done by the bidder without any additional cost.

10.11.5.6 The bidder shall furnish all the necessary elements to lay the cables through the anti fire partitions, floors and walls and the filling material to plug the holes.

10.11.5.7 Based on the cable routing drawing being supplied by the purchaser, the detailed engineering of tier-wise division or allocation of cable routes / cable schedule shall be made by the bidder in the relevant drawings and the same shall be submitted to the purchaser for approval.

10.11.5.8 The cable trays shall be laid on supports, the horizontal distance between supports shall be 1000mm. The top most cable tray in the cable trenches shall be provided with GI tray cover for mechanical protection of cables, Cable trays shall be tack welded to the cable

tray supports or provided with 'U' clamps and fixed to the cable tray supports.

10.12 EARTHING OF CABLES & ACCESSORIES

10.12.1 All bonding clamps at the joints and terminations of the armoured cables & the armour wires shall be solidly earthed. The clamps shall be adequately tightened. This is necessary to ensure proper electrical contact because armour is the only return path for earth fault current.

10.12.2 In case of unarmoured cables, the external metallic earth bonding connector of adequate size should be used. Precautions should be taken to eliminate the chemical and bimetallic corrosion of the earth connectors or bonds.

10.13 REQUIREMENT OF CONDUIT SYSTEM

10.13.1 Conduit system shall be complete with conduits of various types such as rigid metal conduits, non-metallic conduits & flexible conduits with boxes and fittings including all required hardware such as bolts, screws, hangers, concrete inserts, lock-nuts, clamps, bushings, coupling, pulling irons and identification tags etc.

10.13.2 Rigid metal conduits shall be fabricated of seamless, hot-dip galvanized steel. Fittings such as clamps and covers required for fixing metallic conduits shall also be galvanized.

10.13.3 The non-metallic conduits shall be of asbestos-cement for electrical purposes or PVC according to the relevant IS with standard segments of bends, joints, rubber rings, expansion couplings. etc. of approved type.

10.13.4 The flexible conduits shall be of hot-dip galvanized steel or PVC and in all cases these shall be liquid-tight.

10.13 INSTALLATION OF CONDUITS

10.13.1 Installation of all conduits, boxes, fittings and accessories shall meet the requirements of the relevant IS. Whenever the work is interrupted or upon completion, the conduit runs shall be sealed by the use of

plugs or caps and discs. Seals shall not be removed until the conductor is pulled in.

10.13.2 After installation the conduits shall be examined and cleaned by swabs, compressed air or by other methods, before conductors are pulled in. If a permanent block is found during checking or during installation of conductors, the conduit and surrounding concrete shall be replaced without additional expense to the purchaser. All boxes and fittings shall be kept closed and free from foreign matter and moisture.

10.13.3 Metal conduit runs shall be electrically continuous between boxes or equipment and grounded conduits shall be cut square with reamed ends. Conduit joints and threads shall be made thoroughly watertight and rustproof by means of the application of a non-insulating thread compound, such as white lead or equivalent, approved by the purchaser. All conduits terminating outdoors shall be sealed with a sealing compound as approved by the owner. Locknuts shall be used on both sides of slip holes to secure conduits entering boxes.

10.13.4 Concrete embedded conduit shall be sloped towards the drain points, and rigidly supported and braced during concrete placement. If required drain tees shall be installed at suitable low point with one end closed with fine brass mesh to facilitate drainage.

10.13.5 Conduits extending through floors, walls or beam shall be at right angles to the surfaces. Structural steel shall not be cut or drilled without prior written approval of the purchaser.

10.13.6 Conduits terminating at the face of concrete for extensions, shall end with plugged couplings flushed with the walls or floors and plugs shall also be provided for future conduit extensions.

10.13.7 Conduit boxes shall be installed parallel with building lines and flush with the finished surface. Conduit box covers and openings shall be easily accessible. All boxes shifted out of line during concreting or not properly installed, shall be removed and reset without additional expenses to the purchaser.

10.13.8 Conduit runs which are exposed shall be in straight lines parallel to column lines, beams or walls. Offsets shall be uniform and symmetrical. Support for exposed conduit shall be at intervals of not more than 1.5 meters for up to and including twenty one (21) millimeter conduit and not more than 3 meters intervals for twenty nine (29) millimeter conduit and over. Capped conduit and conduit terminating in boxes or fittings shall be supported approximately one hundred and fifty (150) millimeters from the terminal. Boxes and equipment housings shall be supported independently of the conduits.

10.13.9 Bending shall not reduce the conduit internal diameter or damage protective coatings. Bends having a minimum inside diameter ten percent (10%) less than the true diameter of the conduit, shall be rejected.

10.13.10 Permanent plastic tags bearing the conduit designation number shall be attached to each end and at junction and pull boxes. Samples of the proposed tags shall be submitted for approval to the purchaser. Where it is impractical to use tags, such as where conduits terminate at flush mounted boxes or other enclosures, the designations shall be painted inside the enclosure adjacent to the conduits.

10.13.11 All conduits in rooms with false ceiling shall be run concealed. Rooms with tiled walls shall have conduits concealed in walls or ceiling. In all other areas conduits can be either concealed or exposed type subject to the purchaser's approval.

10.13.12 Non-metallic conduits shall be installed as required with duct runs having a minimum pitch towards drainage location of twenty five (25) millimeters per one hundred (100) meters. Non-metallic embedded conduits shall be supported on spacers at maximum intervals of one (1) meter. Spacers shall be rigid & prefabricated type and no makeshift spacers shall be used. Field-cut conduit shall have machine tapered ends made with tools designed for the purpose. If nonmetallic conduit joints are to be installed, these should be

joined tightly with a compound recommended by the conduit manufacturer.

10.13.13 All conduit terminations shall be located as required. Where conduits enter equipment, cubicles or other enclosures, they shall be located by template. The accuracy of location shall be within ten (10) millimeters of the required dimensions, allowing proper spacing and clearances for fittings or attachment to devices. A reasonable amount of de-silting cutting, reaming and relocating holes shall be considered a normal part of the work. Conductors carrying AC & DC supplies shall not be bunched together in a conduit.

10.13.14 Unless otherwise specified, all non-metallic conduit shall be terminated with non-metallic end bells. All conduit terminations shall be sealed with compound harmless to cable and conduit.

10.13.15 Where rigid conduit cannot be used conveniently, short lengths of flexible steel or PVC conduit may be used for connection such as to conduit boxes or motors. Standard flexible conduit fittings shall be used for connection to rigid conduits and boxes. In wet locations and where exposed to the weather, liquid-tight flexible conduit and suitable fittings shall be used.

10.15 WASTAGES

10.15.1 Maximum percentage of wastages of materials that are allowed are as follows:

i) Cables: 1% in respect of each type and size of cable. Cut pieces measuring 5 metres and above shall not be considered as wastage.

ii) Steel for fabrication 2%

iii) All other items Nil

10.15.2 All cut pieces against any of the item, where wastage is allowed, shall be the property of the purchaser only.

10.15.3 In case wastages are found to be more than the maximum percentage indicated above, the purchaser shall recover the cost of such additional wastages from the bidder's bills at the contracted rates.

10.15.4 Tolerance on drum length of cables shall be as per the relevant IS only.

10.16 CABLE MARKERS AND CABLE BINDING

Suitable cable markers of aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable should be easily identified.

10.17 CABLE BINDING/STRAPPING

All control cables from glands shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel will be such that it gives a neat appearance and good workmanship.

For LT Power cables, suitable holding clamps will be provided in the panel if required.

10.18 ERECTION OF PANEL CUT-OUTS & GLAND PLATES

10.18.1 The panels (supplied by others) are provided with cable gland plates in the bottom. A few panels shall have top cable entry for cables. Suitable holes in bottom/top cable entry gland plates will be done by the bidder as required.

10.18.2 The bidder shall also be responsible for sealing the spare holes and panel cut-outs with the help of suitable gland plates or mutually agreed method. All materials are covered in the bidder's scope of supply.

10.19 CABLE ACCESSORIES

10.19.1 General

The bidder shall supply all the required accessories that may be found necessary during actual execution of the work within the quoted prices. No intermediate joint will be allowed in the run of

any cable, except for the case when the required length is more than the drum length.

10.19.2 Cable lugs

The bidder has to supply necessary lugs corresponding to the cable sizes given in the Schedule of Requirements. These shall be made of aluminium or copper corresponding to the conductor of cables. The bidder shall ensure that no bimetallic action takes place, between the aluminium conductor of the cable and the cable connecting lugs.

10.19.3 Cable Glands

The cable glands shall be double compression glands made of brass duly electrotinned in order to avoid corrosion and oxidation of the surface. The nipple threads shall be in accordance with IS 1653. Glands shall provide neat, tight, dust and vermin proof termination. Glands shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Glands shall be complete with suitable washers etc. Cable glands shall incorporate built-in facilities for earthing the armour of cables.

10.19.4 Cable Marker Ferrules

The cable and wire markers shall be made of best quality material. Ferrules shall have deep, large and permanent marking of alfa-numerical symbols which can't be erased. Suitable sticker type ferrules for power cables may be supplied. These shall be marked as per purchaser's cable schedule such that each core of each cable can be identified easily.

10.19.5 Self Adhesive Marker

Self adhesive marker in the form of strips of any one character which can be easily peeled from the backing cards and can be applied on the cable shall be supplied. The strips shall be water-proof duly marked with a special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per owner's cable schedule such that each core of each cable can be identified easily.

10.19.6 Tags

Aluminium strip of 19 mm width and 2 mm thickness for making tags or any other better alternative (details to be furnished with the bid) for labels shall be supplied.

10.19.7 Other Accessories

PVC tapes, cotton tapes etc. required for laying, termination, testing & commissioning shall be supplied. These materials & accessories shall be of good quality as per relevant IS.

All the accessories described in clause 10.25.9 shall be supplied and used by the contractor during the installation of cables. After the completion of work, at least 5 % of the quantities used of each of the following accessories but not less than 1 pc. of each type shall be handed over to the owner for future use.

Accessories	
i)	Termination kits for each cable size
ii)	Sealing ends for each cable size
iii)	Cable lugs for each cable size
iv)	Double compression Cable glands for each cable size
v)	Straight through joints for each cable size
vi)	Button Tape
vii)	Cable marker ferrules
viii)	Self adhesive marker
ix)	Aluminium Strips
x)	Cable trays & racks (for each type)
xi)	Cable junction boxes
xii)	Metal conduits, flexible conduits and PVC conduits (for each type)
xiii)	Cable rack supporting structure ((for each type)

10.20 SCHEDULE OF GUARANTEED & OTHER TECHNICAL PARTICULARS

Guaranteed & other technical particulars as per Annexure-I shall be furnished along with the bid. The particulars which are subject to guarantee shall be clearly marked. Any bid lacking complete information in this respect is likely to be rejected.

10.21 COMPLETENESS OF CONTRACT

The bidder shall be fully responsible for completeness of the contract including any item not mentioned explicitly but considered necessary to meet requirement of the work specified in these specifications and as per relevant IS and code of practice for electrical installation under Indian Electricity rules/Act.

10.22 WORK COMPLETION & DELIVERY SCHEDULE

10.22.1 The design & manufacturing works pertaining to cables, cable racks & accessories shall be carried out so that the delivery of all of these items to the project site would be completed before the date mutually agreed to start the execution work at site and the laying of cables, erection of cable racks, supports etc., testing and commissioning of the above items at site would be completed upto the completion date of the contract.

10.22.2 The bidder shall furnish PERT chart /deployment of manpower at site for the execution of various activities suiting above commissioning schedule at detailed engineering stage.

10.23 COORDINATION WITH OTHERS

10.23.1 The bidder shall coordinate in every respect and freely exchange necessary technical data with other suppliers/contractors as and when required under intimation to the purchaser to ensure proper coordination and completion of the work in time.

10.24 SCHEDULE OF REQUIREMENTS

10.24.1 The cables of all types & sizes shall have the following properties:

Oxygen index	Min. 29
Smoke density	Min. 40% light transmittance
Acid gas	Max. 20% by weight
Flame propagation	Shall meet IEC 332-1,2,3; IEEE 383 & SEN 4241475 (Class F 3)

10.24.3 Power Cables of 1100V Grade, multi-core cables

10.24.3.1 These cables shall be of 1100 volts grade, heavy duty, multi-core, stranded aluminium conductor (copper conductor for DC supply), HR-PVC insulated, colour coded, unarmoured or armoured, inner sheathed with extruded PVC, FRLS type conforming to IS 1554 (Pt. I). The outer sheath is of specially formulated PVC compound.

10.24.3.2 Cable Sizes

Sl. No.	Cable sizes No. of cores x mm^2	Voltage Grade
A.	**Aluminium Conductor**	
i)	3 ½ C x 300 / 150	1100 V
ii)	3 ½ C x 185 / 95	1100 V
iii)	3 ½ C x 150 / 70	1100V
iv)	3 ½ C x 120 / 70	1100 V
v)	3 ½ C x 95 / 50	1100 V
vi)	3 ½ C x 70 / 35	1100 V
vii)	3 ½ C x 50 / 25	1100 V
viii)	3 ½ C x 35 / 16	1100 V
ix)	3 ½ C x 25 / 16	1100 V
x)	4 C x 10	1100 V
B.	**Copper Conductor**	
xi)	2C x 70	1100 V
xii)	2C x 50	1100 V
xiii)	2C x 25	1100 V
xiv)	2C x 16	1100 V
xv)	2 C x 10	1100 V

10.24.4 Power Cables of 1100V Grade, single-core cables

10.24.4.1 These cables shall be of 1100 volts grade, heavy duty, single-core, stranded aluminium conductor , HR-PVC insulated, armoured / unarmoured , inner sheathed with extruded PVC, FRLS type conforming to IS 1554 (Pt. I). The outer sheath shall be of specially formulated PVC compound.

10.24.4.2 Cable Sizes

Sl. No.	**Cable size No.of cores x mm²**	**Voltage Grade**
A.	**Aluminium Conductor**	
i)	1C x 800	1100 V
Ii)	1C x 500	1100 V
Iii)	1C x 400	1100 V
Iv)	1C x 240	1100 V
v)	1C x 185	1100 V

10.24.6 Lugs for 1100V Grade Power Cables:

Adequate quantity of cable lugs not limited to the quantity as indicated below, for AC&DC power cables as specified under clauses 10.19.7 shall be supplied & erected at site by the bidder:-

a) Lugs for 415V AC Aluminium Conductor Power Cables

Cable Size

800 mm^2
500 mm^2
400 mm^2
300 mm^2
240 mm^2
185 mm^2

150 mm^2
120 mm^2
95 mm^2
70 mm^2
50 mm^2
35 mm^2
25 mm^2
16 mm^2
10 mm^2

b) Lugs for 220 V DC Copper Conductor Power Cables

Cable Size

70 mm^2
50 mm^2
25 mm^2
16 mm^2
10 mm^2

10.24.7 Cable Trays, Racks, Supports etc. of Required Sizes

Trays
400 mm 60 mm (ht.)
• Ladder type
• Perforated type
500 mm x 60 mm (ht.)
• Ladder type
• Perforated type
Racks
• ISA(50x50x6) mm
Rack/Ladder Covers
• Suitable for 400 mm racks
• Suitable for 500 mm racks
Supports
• Channelfor Embedment
ISMC 150 with flange thk. of 9 mm and web thk. 6.5 mm)
ISMC 75(with flange thk. of 9 mm and web thk. 4.8 mm)
• Earthing Flat (50 x 6 mm GI flat)
• GI Flat (25 x 6 mm)

10.24.8 a) Cable Glands, Straight Through Joints for all types and sizes of power cables, as specified below:

1. Armoured Cable Glands

i)	1C X 400 mm^2
ii)	1C X 185 mm^2
iii)	2C X 70 mm^2 (DC Copper Cables)
iv)	2C X 25 mm^2 (DC Copper Cables)
v)	2C X 16 mm^2 (DC Copper Cables)
vi)	3½C X 185/95 mm^2
vii)	3½C X 150/70mm^2
viii)	3½C X 120/70mm^2
ix)	3½C X 95/50 mm^2
x)	3½C X 50/25 mm^2
xi)	3½C X 35/16 mm^2
xii)	3½C X 25/16 mm^2

2. Un-armoured Cable Glands

i)	1C X 800 mm^2
ii)	1C X 500 mm^2
iii)	1C X 400 mm^2
iv)	1C X 240 mm^2
v)	1C X 185 mm^2
vi)	2C X 70 mm^2 (DC Copper Cables)
vii)	2C X 50 mm^2 (DC Copper Cables)
viii)	2C X 25 mm^2 (DC Copper Cables)
ix)	2C X 16 mm^2 (DC Copper Cables)
x)	2C X 10 mm^2 (DC Copper Cables)
xi)	3½C X 300/150 mm^2
xii)	3½C X 185/95mm^2
xiii)	3½C X 150/70 mm^2
xiv)	3½C X 120/70 mm^2
xv)	3½C X 95/50 mm^2
xvi)	3½C X 70/35 mm^2
xvii)	3½C X 50/25 mm^2
xviii)	3½C X 35/16 mm^2
xix)	3½C X 25/16 mm^2
xx)	4 C X 10 mm^2

3. Straight Through Joint

i)	Suitable for 11 kV XLPE insulated 300 sq mm, armoured aluminium conductor cable
ii)	Suitable for 1.1 kV grade PVC insulated 70 sq mm, copper conductor, armoured DC power cable
iii)	Suitable for 1.1 kV grade PVC insulated 50 sq mm, copper conductor, armoured DC power cable

10.24.10 Other Accessories

i) Cable glands, Straight through joints (wherever required), cable cleats / clamps etc. suitable for all type and sizes of cables shall be supplied & erected at site by the bidder.

ii) Requisite quantity of couplings, elbow plates and other fitting accessories for cable trays / racks shall be supplied by the bidder.

iii) GI flat of adequate size and its connection to entire tray and rack system at 5 m interval and further connection to earth mat shall be supplied by the bidder.

iv) Brackets, rock bolts, embedment plates etc. supporting the tray & rack system shall be supplied as per requirement.

v) The quantities of all items for supply and erection / laying of cables & accessories given above are only tentative & indicative and final quantities shall be as per layout drawings or as per cable routing drawing prepared by the bidder & approved by the purchaser during detailed engineering and / or as per changed route during erection. However, for the purpose of bid evaluation, above quantities shall be considered based on the unit rates quoted by the bidder. The required amendment in cable route shall be implemented into final drawings. The necessary work generated due to amendment shall be carried out by the bidder without any extra cost to THDC.

10.24.11 Control Cables

10.24.11.1 The control cables shall be of 650 V grade, heavy duty, multi-core, colour coded or core numbered, annealed high conductivity stranded copper conductor, insulated with HR PVC insulation, Un-armoured, PVC sheathed, FRLS, conforming to IS 1554 (Part-I & II). The outer sheath is of specially formulated PVC compounds.

S.No.	Cable Size No. of core x mm^2	Voltage Grade
1	4 core x 1.5 mm^2	650 V
2	7 core x 1.5 mm^2	650 V
3	16 core x 1.5 mm^2	650 V
4	4 core x 2.5 mm^2	650 V
5	4 core x 4 mm^2	650 V

10.26 SPARES

10.26.1 Mandatory spare parts for 5-years of normal operation period shall be quoted

10.26.2 Spare parts shall be identical to those used in the original equipment. These spare parts shall be subjected to the similar inspection and tests at works and shall be included in the same shipment as the complete equipment. These parts shall be packed in separate containers and clearly marked “SPARE PARTS”.

10.26.3 Spare part code numbers and original manufacturer’s designation shall be furnished to facilitate reordering.

10.26.4 The supplier shall indicate all special conditions required for long-term storage of spare parts.

Annexure-I

GUARANTEED AND OTHER TECHNICAL PARTICULARS

Information asked below shall be furnished separately for all the cables, racks, trays, supports etc. in tabular form :

Sl. No.	Description of Items	Unit	Technical Particulars

1. CABLES

1.1. General

i) Name & Address of the bidder
ii) Name & factory address of the manufacturer
iii) Validity of the tender
iv) Cable type (11kV XLPE, 415V AC & 220V DC)
v) Standard applicable
vi) Suitability for earthed / unearthed system
ii) Armoured/Unarmoured type

1.2. Conductor And Conductor Screen

a)	Material of conductor	
b)	Nominal cross sectional area of the conductor	mm^2
c)	Form of conductor (circular/shaped)	
d)	Minimum No. of strands	
e)	Nominal dia of each strand	(mm)
f)	Whether strands are tinned (Yes/No)	
g)	Temperature coefficient of resistance at 20°C	

1.3. Insulation

a)	Material	
b)	Minimum average thickness	(mm)
c)	Tolerance on thickness of insulation	%
d)	Dia of core over insulation	(mm)
e)	Minimum value of resistivity at 20°C	MΩ
f)	Minimum value of resistivity at 70°C	MΩ
g)	Core identification scheme	
h)	Average dielectric strength	kV/mm

Sl. No.	Description of Items	Unit	Technical Particulars
i)	Suitability with regard to moisture, acid, oil and alkaline surroundings		

1.4. Insulation Screen

a)	Whether extruded insulation screen is applied	
b)	Material of the insulation screen	
c)	Thickness of the insulation screen	(mm)
d)	Whether extruded under triple extrusion process	

1.5. Armouring

a)	Armouring material	
c)	Thickness / dia of the steel tape / wire	(mm)

1.6 Outer Sheath/Overall Covering

.

a)	Material	
b)	Whether extruded type	
c)	Minimum average thickness	(mm)
d)	Tolerance on the thickness of outer sheath	(mm)
e)	Dia of the cable under the sheath	(mm)
f)	Whether anti-termite treatment has been given in the outer sheath	

1.7 Electrical Properties of Cables

.

a)	Maximum DC conductor resistance at 20°C	(ohm/km)
b)	Maximum DC conductor resistance at 70°C	(ohm/km)
c)	Maximum permissible conductor temperature i) Under continuous full load condition ii) Under transient loading conditions	(°C)
d)	Loss tangent (δ) at normal frequency	
e)	Reactance at 50 Hz	(Ohm / km)
f)	Capacitance at 50 Hz	(F / km)
g)	Guaranteed total power losses in each circuit without tolerance at maximum permissible conductor temperature.	(KW)

(V)

Sl. No.	Description of Items	Unit	Technical Particulars
h)	Voltage Rating i) Rated voltage ii) Voltage drop per Km	(V / km) (kVrms)	
i)	Dielectric Strength i) Power frequency withstand voltage ii) Rated impulse withstand voltage	(kVpeak)	
j)	Current Ratings		
	i) In air (continuous) at 38^0C ambient temp.	(Amp)	
	ii) In duct (continuous) at 38^0C ambient temp.	(Amp)	
	iv) Short circuit current rating for 1 sec.	(kA)	

1.8 Mechanical Properties of Cables

.

a)	Overall diameter of the cable	(mm)
b)	Diameter of the cable under the outer sheath	(mm)
c)	Diameter over the stranded core	(mm)
d)	Weight of cable per km	(kg)
e)	Total weight of non-metallic material	kg/metre
f)	Recommended minimum installation radius	
g)	Maximum safe pulling force	(Newton)
h)	Whether cable identification (marking) as per the specification is being provided	(Yes/No)

1.9 Cable Drum

a)	Over all dimensions of the drum	(mm)
b)	Total weight of the drum	(kg)
c)	Whether packing has been done as per the specification	(Yes/No)

2. CABLE ACCESSORIES

2.1 Cable Trays, Racks, Supports etc.

a)	Manufacturer's name	
b)	Address	
c)	Material specification	
d)	Maximum permissible loading weights with the proposed supporting arrangement	Kg/m
e)	Drawing showing arrangement and descriptive pamphlet enclosed	(Yes/No)
f)	Weight of zinc coating	(gm / m^2)

Sl. No.	Description of Items	Unit	Technical Particulars
2.2	**Conduit pipes (for each type & size)**		
	a) Manufacturer's name		
	b) Address		
	c) Applicable standards		
	d) Material specifications		
	e) Whether descriptive pamphlet enclosed	(Yes/No)	
2.3	**Cable termination kit (for each size)**		
	a) Maker's name		
	b) Full description and bill of material for the termination kit		
	c) Whether termination kit is complete with all accessories	(Yes/No)	
	d) Whether descriptive pamphlet enclosed	(Yes/No)	
2.4	**Cable Glands / Sealings (for each size)**		
	a) Type		
	b) Material		
	c) Manufacturer's name		
	d) Address		
	e) Whether descriptive pamphlets are enclosed	(Yes/No)	
2.5	**Cable lugs (for each size)**		
	a) Type		
	b) Material		
	c) Manufacturer's name		
	d) Address		
	e) Whether descriptive pamphlets are enclosed	(Yes/No.)	
2.6	**Straight through joints (for each type & size of cables)**		
	a) Manufacturer's name		
	b) Address		
	c) Whether complete with all accessories as specified	(Yes/No)	
	d) Whether descriptive pamphlets are enclosed	(Yes/No)	

Date: **Signature of the Bidder**

Place : **Seal**

E.11. INDUCTION MOTOR & SYNCHRONOUS MACHINE (Pg 1 of 2)

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/ Chem. Properties	NDT /DP/MPI/UT	Metallographic	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y	Y		Y		
Rotor Copper/Aluminum	Y	Y	Y	Y		Y	Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD,CT, Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y						
Motor (IS 325 / 4722/ 9283)	Y	Y	Y						

E11. **INDUCTION MOTOR & SYNCHRONOUS MACHINE** (Pg 2 of 2)

TESTS/CHECKS / ITEMS/COMPONENTS	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722 / 9283	Vibration	Over speed	Tan delta, shaft voltage & polarization index test
Plates for stator frame, end shield, spider etc.									
Shaft									
Magnetic Material	Y		Y						
Rotor Copper/Aluminum									
Stator copper			Y						
SC Ring									
Insulating Material			Y						
Tubes for Cooler		Y							
Sleeve Bearing		Y							
Stator/Rotor, Exciter Coils									
Castings, stator frame, terminal box and bearing housing etc.									
Fabrication & machining of stator, rotor, terminal box									
Wound stator									
Wound Exciter									
Rotor complete				Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly									
Accessories, RTD, BTD,CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.									
Motor (IS 325 / 4722 / 9283)						Y	Y	Y	Y1

Note**:**

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.
2. All major Bought Out Items will be subject to Owner's approval.
3. Any other tests mentioned in the equipment specification are also to be carried out.
4. The codes and standards mentioned in equipment specification is governing.

	QUALITY PLAN	**CUSTOMER**	**THDCIL**		PROJECT TITLE	**4X111MW VISHNUGAD HEP** **CRANES & HOISTS**		SPECIFICATION NUMBER :	PE-TS-413-501-A001			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE				
	SHEET 1 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN		CUSTOMER	**THDCIL**		PROJECT	**4X111MW VISHNUGAD HEP**		SPECIFICATION	PE-TS-413-501-A001		
						TITLE	**CRANES & HOISTS**		NUMBER :			
			BIDDER/ VENDOR	:		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION	VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

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

	QUALITY PLAN		CUSTOMER : THDCIL			PROJECT **4X111MW VISHNUGAD HEP**			SPECIFICATION PE-TS-413-501-A001			
						TITLE **CRANES & HOISTS**			NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

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

	QUALITY PLAN		CUSTOMER	**THDCIL**		PROJECT	**4X111MW VISHNUGAD HEP**		SPECIFICATION NUMBER :	PE-TS-413-501-A001		
			BIDDER/ VENDOR :			TITLE	**CRANES & HOISTS**					
	SHEET 4 OF 9		SYSTEM			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
						ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

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

	QUALITY PLAN		CUSTOMER	**THDCIL**		PROJECT	**4X111MW VISHNUGAD HEP**		SPECIFICATION	PE-TS-413-501-A001		
						TITLE	**CRANES & HOISTS**		NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

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

	QUALITY PLAN	CUSTOMER	**THDCIL**	PROJECT	**4X111MW VISHNUGAD HEP**
				TITLE	**CRANES & HOISTS**
		BIDDER/ VENDOR	:	QUALITY PLAN NUMBER	PED-506-00-Q-007, REV-03
	SHEET 6 OF 9	SYSTEM		ITEM:	AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)

SPECIFICATION NUMBER :	PE-TS-413-501-A001											
SPECIFICATION : TITLE												
SECTION	VOLUME III											
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

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

	QUALITY PLAN		CUSTOMER	**THDCIL**		PROJECT	**4X111MW VISHNUGAD HEP**		SPECIFICATION NUMBER :	PE-TS-413-501-A001		
			BIDDER/ VENDOR :			TITLE	**CRANES & HOISTS**					
	SHEET 7 OF 9		SYSTEM			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
						ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

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

	QUALITY PLAN		CUSTOMER	**THDCIL**		PROJECT	**4X111MW VISHNUGAD HEP**		SPECIFICATION	PE-TS-413-501-A001		
						TITLE	**CRANES & HOISTS**		NUMBER :			
			BIDDER/ VENDOR	:		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 8 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

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

	QUALITY PLAN	CUSTOMER: **THDCIL**	PROJECT **4X111MW VISHNUGAD HEP**	SPECIFICATION PE-TS-413-501-A001	
			TITLE **CRANES & HOISTS**	NUMBER :	
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE	
	SHEET 9 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION	VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

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

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

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

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

Legends for Inspection agency

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

P. PERFORM
W. WITNESS
V. VERIFY

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

	QUALITY PLAN		**CUSTOMER : THDCIL**			PROJECT TITLE	**4X111 MW VISHNUGAD HEP** **CRANES & HOISTS**		SPECIFICATION : PE-TS-413-501-A001 NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
	SHEET 1 OF 2		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
	BHEL		**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

		CUSTOMER : THDCIL				PROJECT **4X111 MW VISHNUGAD HEP**			SPECIFICATION :PE-TS-413-501-A001				
	QUALITY PLAN					TITLE **CRANES & HOISTS**			NUMBER :				
		BIDDER/ VENDOR :				QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :				
	SHEET 2 OF 2	SYSTEM				ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS	
1	2	3	4	5	6	7	8	9	10			11	
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-		

NOTES:

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

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

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

Legends for Inspection agency

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

P. PERFORM
W. WITNESS
V. VERIFY

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

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
		IRIZAR FORGE		FOR MORE THAN 250T 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)		
		BCH		
9.	OVER LOAD RELAYS	SIEMENS		
		L&T		
		ABB		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		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		
		OSC		
		TARGET		
		KHERAJ		
18.	LIGHTING SWITCHES	ANCHOR		
		ELLORA		
		BAJAJ		
		PHILIPS		
19.	PVC POWER CABLES	APAR INDUSTRIES LTD.	MUMBAI	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		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	
		CORDS CABLE INDUSTRIES LTD	NEW DELHI	
		CRYSTAL CABLE INDUSTRIES LTD	KOLKATA	
		DELTON CABLES LTD	NEW DELHI	
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		ELKAY TELELINKS LTD	NEW DELHI	
		GEMSCAB INDUSTRIES LTD	NEW DELHI	
		GOVIND CABLE INDUSTRIES	KOLKATA	
		GUPTA POWER INFRASTRUCTURE LIMITED	BHUBNESWAR	
		HAVELLS INDIA LIMITED	NOIDA	
		INCOM CABLES (P) LTD	NEW DELHI	
		KEI INDUSTRIES LTD	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		KEC INTERNATIONAL LIMITED	MUMBAI	
		MANSFIELD CABLES COMPANY LTD	NOIDA	
		NICCO CORPORATION LTD	KOLKATA	
		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	
		SAM CABLES & CONDUCTORS (P) LTD	UDHAM SINGH NAGAR	
		SPM POWER & TELECOM PVT. LTD	HYDERABAD	
		TORRENT CABLES LTD	AHMEDABAD	
		THERMO CABLES LTD	HYDERABAD	
		TIRUPATI PLASTOMATICS PVT. LTD	JAIPUR	
		UNIVERSAL CABLES LTD	SATNA	
21.	**TRAILING CABLES**	NICCO	KOLKATA	
		UNIVERSAL	SATNA	
		INCAB		
		ICL	NEW DELHI	
		APAR INDUSTRIES LTD	MUMBAI	
		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	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		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 LTD	GWALIOR	
		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		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
30.	INDICATING LAMPS	TECKNIC		
		BCH		
		SIEMENS		
		STANDARD		
31.	MCB	MDS		
		INDO COPP		
		STANDARD		
		SIEMENS		
		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		
		TOSHIBA INDIA PVT. LTD.	GURGAON	
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*		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		NAW*		
		NORD*		
		SEW*		
		BONGFILIOLI*		
41.	**RAIL**	JSPL		
		SAIL		
42	**SINGLE GIRDER CRANE**	Alpha Services	Bhiwadi	
		BRADY & MORRIS ENGINEERING CO. LTD.	Ahmedabad	
		CONSOLIDATED HOISTS PVT LTD	Pune	
		CENTURY CRANE ENGINEERS PVT. LTD.	Faridabad	
		GMW PRIVATE LIMITED	Vadodara	
		Henan Weihua Heavy Machinery Co. Ltd.	China	
		Mangla Hoists Pvt Ltd	New Delhi	
		MEEKA MACHINERY PVT. LTD.	Ahmedabad	
		REVA INDUSTRIES LTD.	Faridabad	
		TRACTEL TIRFOR INDIA PVT. LTD.	Faridabad	
		TECHNO INDUSTRIES	Ahmedabad	
		Universal Hoist-O-Fabrik	Thane	
		OEM		

NOTE:

1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER 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.

ANNEXURE-II

LIST OF MANDATORY SPARES

1. MANDATORY SPARE LIST FOR POWER HOUSE CRANE

S. No	DESCRIPTION OF EQUIPMENT / ITEM	Qty
1	Bearing for	
1.1	Bridge travel wheels	**4 nos.**
1.2	Trolley wheels	**2 nos.**
1.3	Monorail wheel	**2 nos.**
1.4	Long travel motor	**2 set**
1.5	Cross travel motor	**2 set**
1.6	Main hoist motor	**2 set**
1.7	Aux. hoist motor	**2 set**
1.8	Monorail hoist motor	**2 nos.**
1.9	Main hook, Aux. hook, Monorail hook	**2 set**
1.10	L.T., C.T., M.H. & A. H., Monorail gear boxes	**2 set**
1.11	Bearing for lifting beams	**2 set**
1.12	Rope drums	**2 set**
1.13	Pulleys for main hoist	**2 set**
1.14	Pulleys for aux. hoist	**2 set**
1.15	Pulleys for monorail hoist	**2 set**
2	Pair of brake shoe / disc with lining for each size of brake used viz. D.C. operated ,Electro-Mechanical, Hydraulic or Thruster operated for	
2.1	Long travel motion	**4 sets**
2.2	Cross travel motion	**4 sets**
2.3	Main hoist	**4 sets**
2.4	Auxiliary hoist	**4 sets**
2.5	Monorail hoist	**4 sets**
3	Pair of brake linings with rivets for each size of brake used for	
3.1	Long travel motion	**4 sets**
3.2	Cross travel motion	**4 sets**
3.3	Main hoist	**4 sets**
3.4	Auxiliary hoist	**4 sets**
3.5	Monorail hoist	**4 sets**
4	Main springs for each size of brake used for	
4.1	Long travel motion	**2 sets**
4.2	Cross travel motion	**2 sets**
4.3	Main hoist	**2 sets**

4.4	Auxiliary hoist	**2 sets**
4.5	Monorail hoist	**2 sets**
5	Brake shoe with lining for foot operated hydraulic brake for	
5.1	Long travel motion	**4 sets**
5.2	Cross travel motion	**4 sets**
5.3	Main hoist	**4 sets**
5.4	Auxiliary hoist	**4 sets**
5.5	Monorail hoist	**4 sets**
6	Brake coils for each size of brake used	
6.1	Long travel motion	**2 sets**
6.2	Cross travel motion	**2 sets**
6.3	Main hoist	**2 sets**
6.4	Auxiliary hoist	**2 sets**
6.5	Monorail hoist	**2 sets**
7	Current collectors for DS	**10 Nos.**
8	Insulator for conductors support assembly	**12 nos.**
9	Limit switches	**Two of each type**
10	Thruster of each size used	**4 nos.**
11	Pair of oil seals for each gear box used	**8 sets**
12	Contactors of each size used	**2 nos.**
13	Fixed & Moving contacts of each size of Contractors used.	**2 sets**
14	3 Nos. coils for each size of contactor used for	
14.1	Main hoist	**4 sets**
14.2	Auxiliary hoist	**4 sets**
14.3	Cross travel	**4 sets**
14.4	Long travel	**4 sets**
15	3 nos. fuse links of each size used on crane	**8 sets**
16	printed circuit of each size and type	**2 sets**
17	2 resistor elements of each type and size	**4 sets**
18	Complete set of lamps for lighting and signals	**2 sets**
19	Timers	**6 nos.**
20	Lubricant for wire rope	**40 trs.**

2 MANDATORY SPARE LIST FOR BUTTERFLY VALVE AREA CRANE

S. No	DESCRIPTION OF EQUIPMENT / ITEM	Qty
1	Bearing for	
1.1	Bridge travel wheels	**2 nos.**
1.2	Trolley wheels	**1 no.**

1.3	Monorail wheel	**1 no.**
1.4	Long travel motor	**1 set**
1.5	Cross travel motor	**1 set**
1.6	Main hoist motor	**1 set**
1.7	Aux. hoist motor	**1 set**
1.8	Monorail hoist motor	**N.A.**
1.9	Main hook, Aux. hook, Monorail hook	**1 set**
1.10	L.T., C.T., M.H. & A. H., Monorail gear boxes	**1 set**
1.11	Bearing for lifting beams	**N.A.**
1.12	Rope drums	**1 set**
1.13	Pulleys for main hoist	**1 set**
1.14	Pulleys for aux. hoist	**1 set**
1.15	Pulleys for monorail hoist	**N.A.**
2	Pair of brake shoe / disc with lining for each size of brake used viz. D.C. operated ,Electro-Mechanical, Hydraulic or Thruster operated for	
2.1	Long travel motion	**2 sets**
2.2	Cross travel motion	**2 sets**
2.3	Main hoist	**2 sets**
2.4	Auxiliary hoist	**2 sets**
2.5	Monorail hoist	**N.A.**
3	Pair of brake linings with rivets for each size of brake used for	
3.1	Long travel motion	**2 sets**
3.2	Cross travel motion	**2 sets**
3.3	Main hoist	**2 sets**
3.4	Auxiliary hoist	**2 sets**
3.5	Monorail hoist	**N.A.**
4	Main springs for each size of brake used for	
4.1	Long travel motion	**1 set**
4.2	Cross travel motion	**1 set**
4.3	Main hoist	**1 set**
4.4	Auxiliary hoist	**1 set**
4.5	Monorail hoist	**N.A.**
5	Brake shoe with lining for foot operated hydraulic brake for	
5.1	Long travel motion	**2 sets**
5.2	Cross travel motion	**2 sets**
5.3	Main hoist	**2 sets**
5.4	Auxiliary hoist	**2 sets**
5.5	Monorail hoist	**N.A.**
6	Brake coils for each size of brake used	
6.1	Long travel motion	**1 set**
6.2	Cross travel motion	**1 set**

6.3	Main hoist	**1 set**
6.4	Auxiliary hoist	**1 set**
6.5	Monorail hoist	**N.A.**
7	Current collectors for DS	**5 Nos.**
8	Insulator for conductors support assembly	**6 nos.**
9	Limit switches	**One of each type**
10	Thruster of each size used	**2 nos.**
11	Pair of oil seals for each gear box used	**4 sets**
12	Contactors of each size used	**1 nos.**
13	Fixed & Moving contacts of each size of Contractors used.	**1 set**
14	3 Nos. coils for each size of contactor used for	
14.1	Main hoist	**2 sets**
14.2	Auxiliary hoist	**2 sets**
14.3	Cross travel	**2 sets**
14.4	Long travel	**2 sets**
15	3 nos. fuse links of each size used on crane	**4 sets**
16	printed circuit of each size and type	**1 set**
17	2 resistor elements of each type and size	**4 sets**
18	Complete set of lamps for lighting and signals	**2 sets**
19	Timers	**3 nos.**
20	Lubricant for wire rope	**20 Ltrs.**

3 MANDATORY SPARE LIST FOR GIS HALL AREA CRANE

S. No	DESCRIPTION OF EQUIPMENT / ITEM	Qty
1	Bearing for	
1.1	Bridge travel wheels	**2 nos.**
1.2	Trolley wheels	**1 no.**
1.3	Monorail wheel	**1 no.**
1.4	Long travel motor	**1 set**
1.5	Cross travel motor	**1 set**
1.6	Main hoist motor	**1 set**
1.7	Aux. hoist motor	**N.A.**
1.8	Monorail hoist motor	**N.A.**
1.9	Main hook, Aux. hook, Monorail hook	**1 set**
1.10	L.T., C.T., M.H. & A. H., Monorail gear boxes	**1 set**
1.11	Bearing for lifting beams	**N.A.**
1.12	Rope drums	**1 set**
1.13	Pulleys for main hoist	**1 set**
1.14	Pulleys for aux. hoist	**N.A.**

1.15	Pulleys for monorail hoist	**N.A.**
2	Pair of brake shoe / disc with lining for each size of brake used viz. D.C. operated ,Electro-Mechanical, Hydraulic or Thruster operated for	
2.1	Long travel motion	**2 sets**
2.2	Cross travel motion	**2 sets**
2.3	Main hoist	**2 sets**
2.4	Auxiliary hoist	**N.A.**
2.5	Monorail hoist	**N.A.**
3	Pair of brake linings with rivets for each size of brake used for	
3.1	Long travel motion	**2 sets**
3.2	Cross travel motion	**2 sets**
3.3	Main hoist	**2 sets**
3.4	Auxiliary hoist	**N.A.**
3.5	Monorail hoist	**N.A.**
4	Main springs for each size of brake used for	
4.1	Long travel motion	**1 set**
4.2	Cross travel motion	**1 set**
4.3	Main hoist	**1 set**
4.4	Auxiliary hoist	**N.A.**
4.5	Monorail hoist	**N.A.**
5	Brake shoe with lining for foot operated hydraulic brake for	
5.1	Long travel motion	**2 sets**
5.2	Cross travel motion	**2 sets**
5.3	Main hoist	**2 sets**
5.4	Auxiliary hoist	**N.A.**
5.5	Monorail hoist	**N.A.**
6	Brake coils for each size of brake used	
6.1	Long travel motion	**1 set**
6.2	Cross travel motion	**1 set**
6.3	Main hoist	**1 set**
6.4	Auxiliary hoist	**N.A.**
6.5	Monorail hoist	**N.A.**
7	Current collectors for DS	**5 Nos.**
8	Insulator for conductors support assembly	**6 nos.**
9	Limit switches	**One of each type**
10	Thruster of each size used	**2 nos.**
11	Pair of oil seals for each gear box used	**4 sets**
12	Contactors of each size used	**1 nos.**
13	Fixed & Moving contacts of each size of Contractors used.	**1 set**
14	3 Nos. coils for each size of contactor used for	

14.1	Main hoist	**2 sets**
14.2	Auxiliary hoist	**N.A.**
14.3	Cross travel	**2 sets**
14.4	Long travel	**2 sets**
15	3 nos. fuse links of each size used on crane	**4 sets**
16	printed circuit of each size and type	**1 set**
17	2 resistor elements of each type and size	**4 sets**
18	Complete set of lamps for lighting and signals	**2 sets**
19	Timers	**3 nos.**
20	Lubricant for wire rope	**20 Ltrs.**

Note:-

1. “One (1) Set” and “One (1) set of each type & size” is defined as 100% requirement for one crane.
2. 100% of total population of each type, size and rating is defined as 100% requirement for one crane.
3. All essential spares shall be supplied as per the requirement of the specifications. In case any spare indicated in the specification is not applicable for particular equipment then suitable applicable alternate spare have been offered / shall be supplied without any financial implication.

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.

One (1) sets each of all mechanical tools, special tools, instruments and devices required for routine maintenance, checking, disassembly, reassembly etc. for each (four number) crane.

S-No.	Description	Qty.
1	Complete set of ring spanners (Indicate the sizes offered)	1 Set
2	Complete set of screwdrivers (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 Jack	1 No.

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.

VOLUME - IIB

ANNEXURE IV

PAINTING AND COLOUR SCHEME

CARBON STEEL SURFACES UNDER COVER THAT STILL RISK CONDENSATION

System chosen	Thickness
1 epoxy priming coat	40 µm
2 coats of colored solvent epoxy pitch	2 x 150 µm

The systems minimum thickness shall be 300 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer and on site intervention shall be limited to touch-ups.

Colour Schedule

	Colour	Standard Ref.
• Enclosures for electrical power equipment	Melon yellow	RAL 1028
• Enclosures for electrical control and protection equipment	Pearl white	RAL 1013

For other items

S.No	ITEM DESCRIPTION	COLOUR SHADE	REMARKS
a	Crane structure	Lemon yellow, shade 356 as per IS-5	
B	Bottom block assembly	Lemon yellow, shade 356 as per IS-5	With black strip
C	Hooks	Lemon yellow, shade 356 as per IS-5	With 100 mm wide black zebra strip
d.	End carriage sweep	Lemon yellow, shade 356 as per IS-5	With black strip
e.	Panels and motors	Steel grey / as req. by purchaser	

Note: Bidder shall prepare detailed painting schedule for cranes in line with above guidelines and make same as part of technical data sheet of crane for approval during detail engineering.

Sl. No	ITEM DESCRIPTION	SURFACE PREP.	PAINTING SCHEME						
			PRIMER	No. of Coats	MIN DFT µ	FINISH	No. of Coats	MIN DFT µ	TOTAL DFT
a	Piping / Structures / Vessels etc. (Temp. up to 90 Deg. C)	Degreasing and Mechanical Cleaning with wire brushing / hand/ power Tool (SA2.5 or equivalent)	Red Oxide Zinc Chromate as per IS: 2074 (alkyd medium)	2	35 per coat	Synthetic Enamel (alkyd Medium) as per IS : 2932	2	25 per coat	120
b	Electrical / Control Panels	Seven Tank Process	zinc phosphate (alkyd medium)	2	25 - 35 per coat	Synthetic Enamel (alkyd med.) as per IS: 2932	3	20 - 25 per coat	110-145

ANNEXURE-V

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:

S.N.	BHEL drawing No.	Title	Approval category	Schedule date of submission from date of LOI.
1	PE-VO-413-501-A001	Manufacturing Quality Plan with sub vendor list For Power house Crane, Butterfly valve house crane and GIS Hall crane	A	7 days
2	PE-V0-413-501-A007	Data sheet for Power house Crane, Butterfly valve house crane and GIS Hall crane with painting details	A	15 days
3	PE-V0-413-501-A003	Data sheet of motors	A	15 days after approval of Mechanism Sizing Calculation in Cat II/Cat I.
4	PE-V0-413-501-A004	Mechanism Sizing Calculation Including storm brake calculation for Power house Crane, Butterfly valve house crane and GIS Hall crane	A	7 days
5	PE-V0-413-501-A005	General arrangement for Power house Crane, Butterfly valve house crane and GIS Hall crane crane with CT DSL details	A	7 days
6	PE-V0-413-501-A006	Crab sub assembly for Power house Crane , Butterfly valve house crane and GIS Hall crane and GIS Hall crane with CT wheel assembly	A	7 days
7	PE-V0-413-501-A032	Gantry Rail installation for Power house Crane, Butterfly valve house crane and GIS Hall crane	A	7 days
8	PE-V0-413-501-A008	General arrangement for PVC shrouded DSL for Power house Crane, Butterfly valve house crane and GIS Hall crane	A	7 days
9	PE-V0-413-501-A009	Main and Auxiliary hook block assembly(as applicable) with details of hook, nut and check plate for Power house Crane, Butterfly valve house crane and GIS Hall crane	I	7 days
10	PE-V0-413-501-A010	Long travel Machinery Assembly with LT wheel assembly for Power house Crane, Butterfly valve house crane and GIS Hall crane	I	15 days
11	PE-V0-413-501-A016	Electrical equipment layout in cabin for Power house Crane	I	10 days

	PE-V0-413-501-A011	Lifting beam assembly drawing for Power House crane.	**A**	**15 days**
12	PE-V0-413-501-A017	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 earthling diagram & write up for Power house Crane, Butterfly valve house crane and GIS Hall crane	**A**	**15 days**
13	PE-V0-413-501-A018	General Arrangement of a) Protective panel b) Main hoist panel c) Aux. hoist panel d) Cross Traverse panel e) Long Traverse panel. f) Pendent g) Remote Radio Control for Power house Crane, Butterfly valve house crane and GIS Hall crane	**A**	**15 days**
14	PE-V0-413-501-A019	Cable Sizing and cable schedule for Power house Crane, Butterfly valve house crane and GIS Hall crane	**A**	**20 days**
15	PE-V0-413-501-A050	Crane lubrication drawing Power house Crane, Butterfly valve house crane and GIS Hall crane	**I**	**20 days**
16	PE-V0-413-501-A012	Structural calculations for Power house Crane, Butterfly valve house crane and GIS Hall crane	**I**	**7 days**
17	PE-V0-413-501-A021	Type test certificate (for motors) Power house Crane, Butterfly valve house crane and GIS Hall crane	**I**	**7 days after approval of Data sheet of motors in Cat II/Cat I.**
18	PE-V0-413-501-A025	Erection procedure Power house Crane, Butterfly valve house crane and GIS Hall crane	**A**	**25 days**
19	PE-V0-413-501-A023	Mandatory spare parts list Power house Crane, Butterfly valve house crane and GIS Hall crane	**A**	**25 days**
20	PE-V0-413-501-A014	O & M manual	**I**	**45 days**
21	PE-V0-413-501-A015	Detailed BOM/BOQ for Power house Crane, Butterfly valve house crane and GIS Hall crane	**I**	**30 days**
22	PE-V0-413-501-A026	Manufacturing Quality plan for Lifting beam for Power house crane	**A**	**7 days**
23	PE-V0-413-501-A027	Sole plate and Anchor bolt drawing for rail fixing arrangement Power house Crane, Butterfly valve house crane and GIS Hall crane	**I**	**7 days**
	LEGENDS			
	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.:-

    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.

ANNEXURE - VI

Format for Operation & Maintenance Manual

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				

4.0	Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	Operation Guidelines for plant personal/user/operator				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				

6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)

PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

1 SCOPE OF THE DOCUMENT

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
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

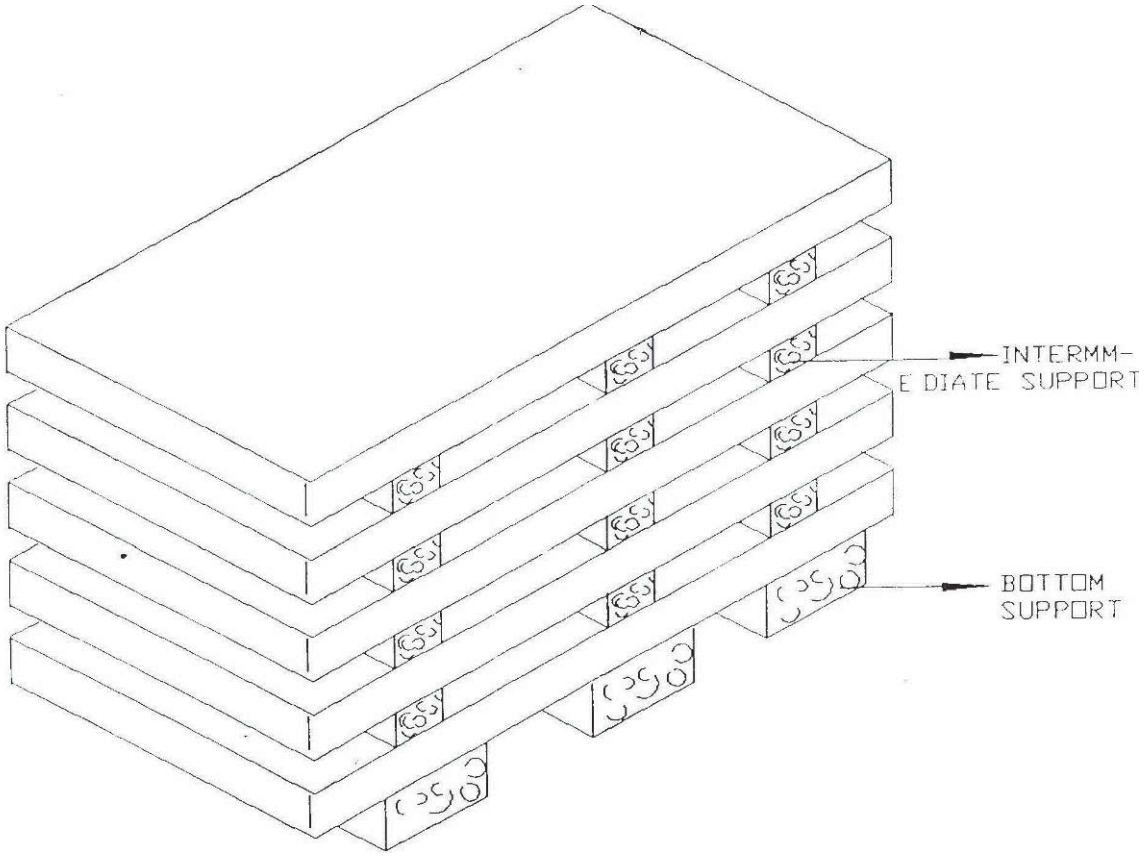


Figure – 1 – PLATE STACKING ARRANGEMENT

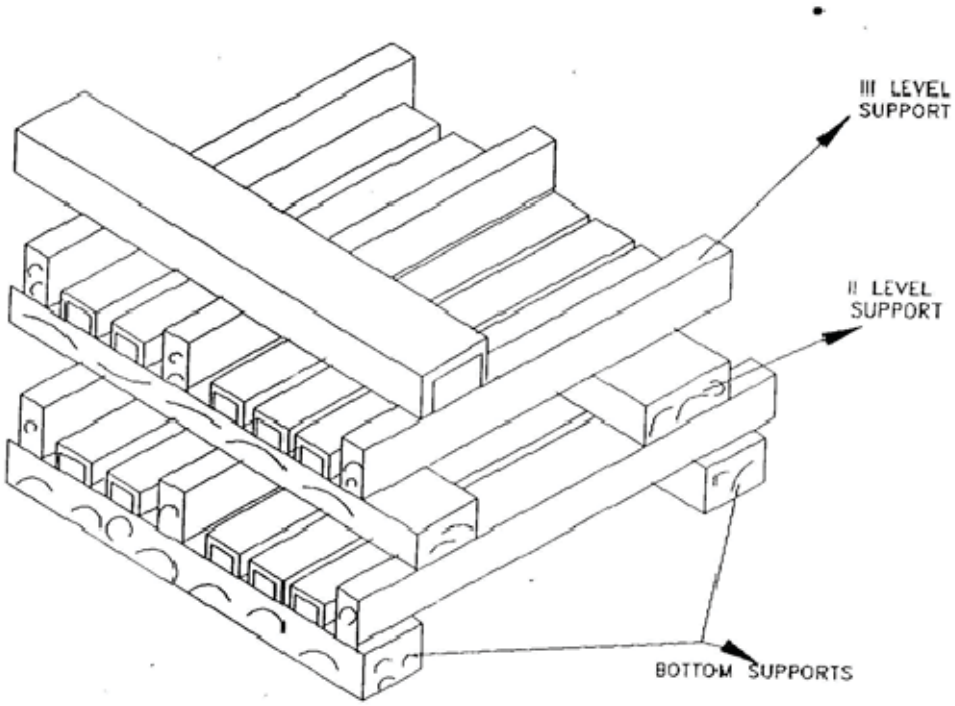


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

ANNEXURE VIII – PACKING PROCEDURE

Packing and Marking

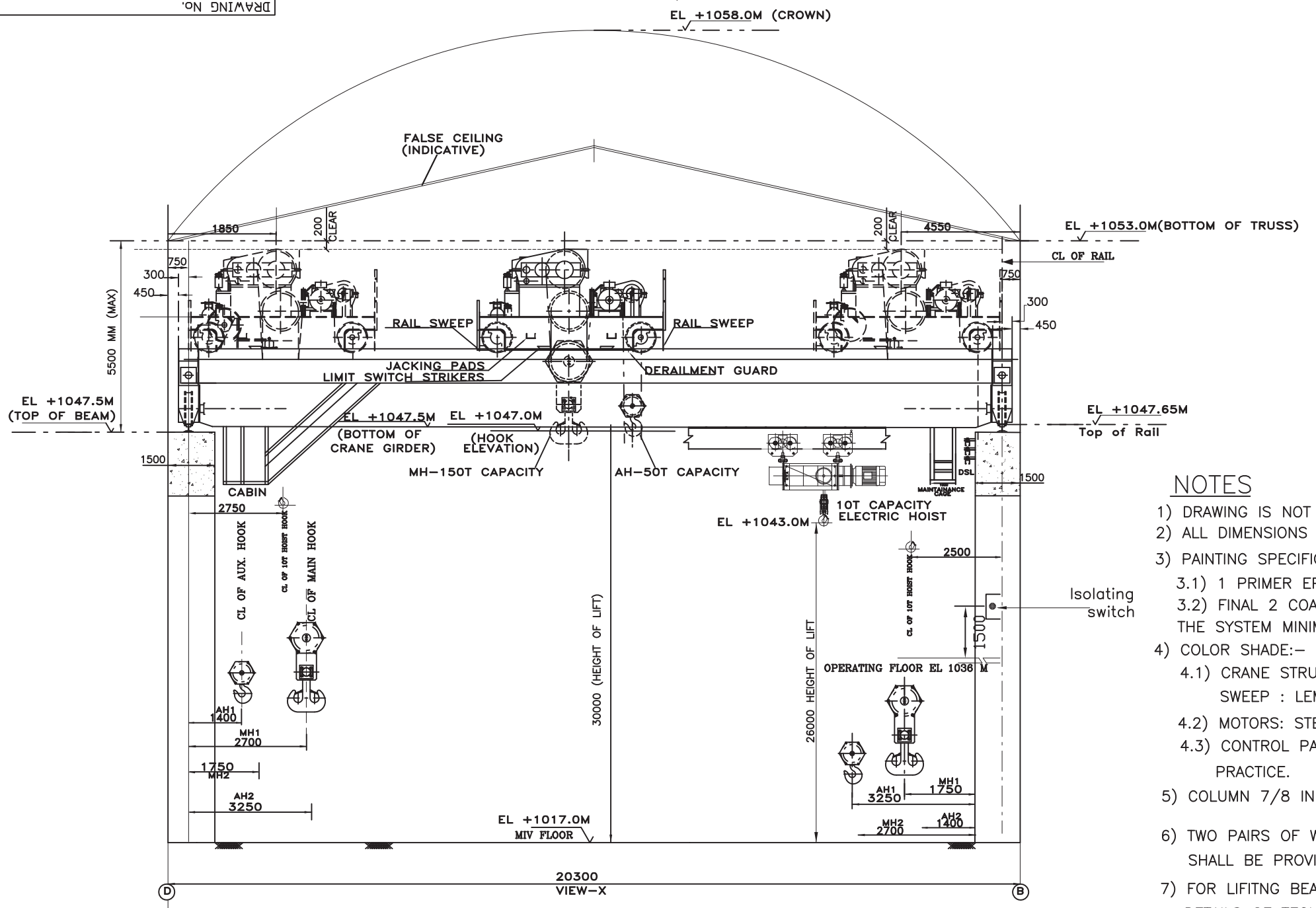
All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper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

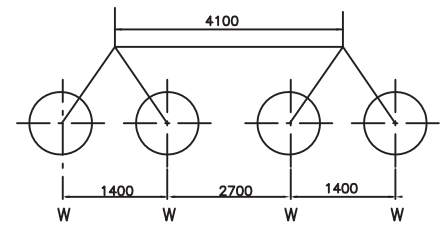
Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

ANNEXURE IX- CRANE CLEARANCE DIAGRAM

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
ALL DIMENSIONS ARE IN MM FIRST ANGLE PROJECTION
Fold-2 Fold-2
3 4 5 6
DRAWING No.
Fold-3 Fold-3
B B
COPY RIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED
it must not be used directly or indirectly in any way detrimental to the interest of the company.
COMPUTER FILE NAME : TAL5
F
Fold-2
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
Page 308



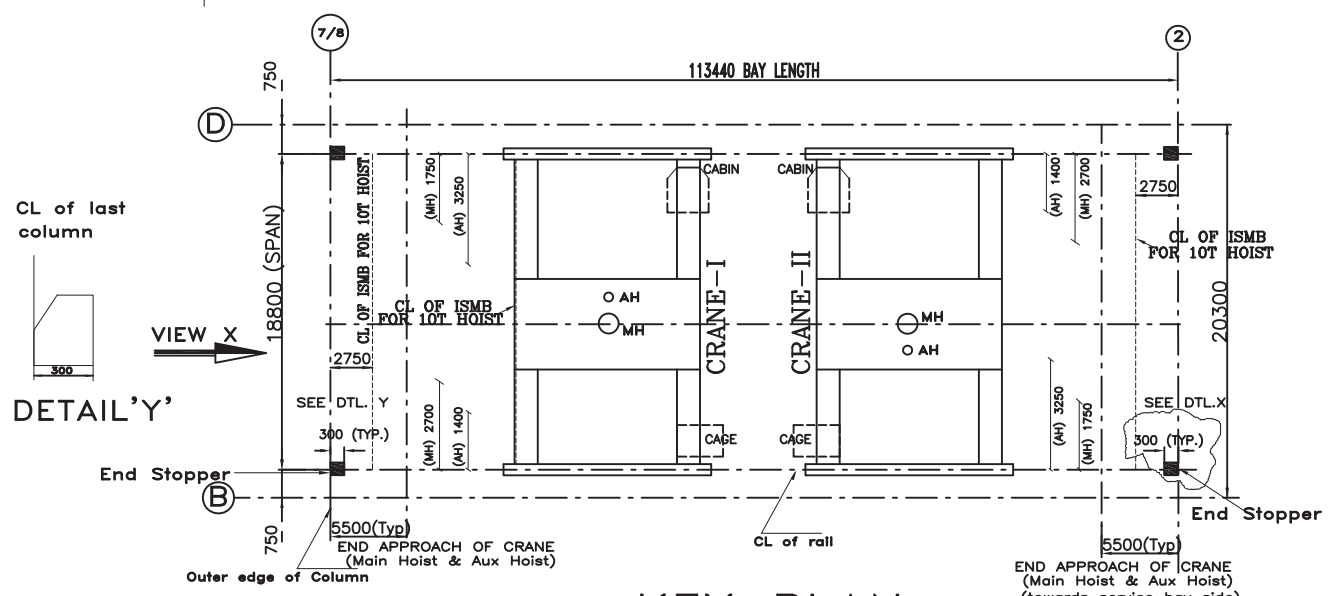
SL NO.	PARAMETER	VALUE
6.	ELECTRIC HOIST HOISTING SPEED	15.0/Ajustable from min. to max. (M/Min)
5.	LT SPEED/CREEP SPEED	20.0/Ajustable from min. to max. (M/Min)
4.	CT SPEED/CREEP SPEED	15.0/Ajustable from min. to max. (M/Min)
3.	AH HOISTING/CREEP SPEED	5.0/Ajustable from min. to max. (M/Min)
2.	MH HOISTING/CREEP SPEED	1.0/Ajustable from min. to max. (M/Min)
1.	DESIGN STANDARD	IS 3177 & IS 807



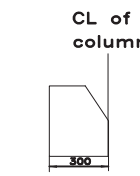
W = 47 TONS
WHEEL LOAD DIAGRAM WITHOUT IMPACT

NOTES

1) DRAWING IS NOT TO THE SCALE.
2) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
3) PAINTING SPECIFICATION:–
   3.1) 1 PRIMER EPOXY ZINC COAT: 40 um.
   3.2) FINAL 2 COATS OF COLORED SOLVENT EPOXY PITCH: 2X150 um.
   THE SYSTEM MINIMUM THICKNESS SHALL BE 300 um.
4) COLOR SHADE:–
   4.1) CRANE STRUCTURE, BOTTOM BLOCK ASSEMBLY, HOOKS AND END CARRIAGE SWEEP : LEMON YELLOW, SHADE 356 AS PER IS–5
   4.2) MOTORS: STEEL GRAY SHADE 692 AS PER IS–5/ AS PER PURCHASER PRACTICE.
   4.3) CONTROL PANELS: STEEL GREY SHADE 698 AS PER IS–5/ AS PER PURCHASER PRACTICE.
5) COLUMN 7/8 INDICATED COLUMN IS ADJACENT TO COLUMN NO. 7
6) TWO PAIRS OF WIRE ROPE SLINGS FOR DIFFERENCE LOADS (I.E. 15 T, 65 T AND 150T SHALL BE PROVIDED.
7) FOR LIFITNG BEAM DETAILS AND ELEVATION, PLEASE REFER ANNEXURE X – LIFTING DETAILS OF TECHNICAL SPECIFICATION.
8) 500 MM CLEARANCE IS TO BE PROVIDED BETWEEN BOTTOM OF CRANE GIRDER ELEVATION AND TOP OF LIFTING BEAM ELEVATION.



KEY PLAN



DETAIL'X'

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

CUSTOMER	THDC INDIA LIMITED (THDCIL)
PROJECT	VISHNUGAD PIPALKOTI HYDROELECTRIC PROJECT (4X111MW)

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
	DRN	RG		13/09/16
	DESN	RG		13/09/16
	CHD	LJ/VK		13/09/16
	APPD	GB		13/09/16

TITLE
CRANE CLEARANCE DIAGRAM OF POWER HOUSE
150/50T DOUBLE GIRDER EOT CRANE WITH 10T ELECTRIC HOIST

DEPT. SCALE - NTS
SIGN
DATE

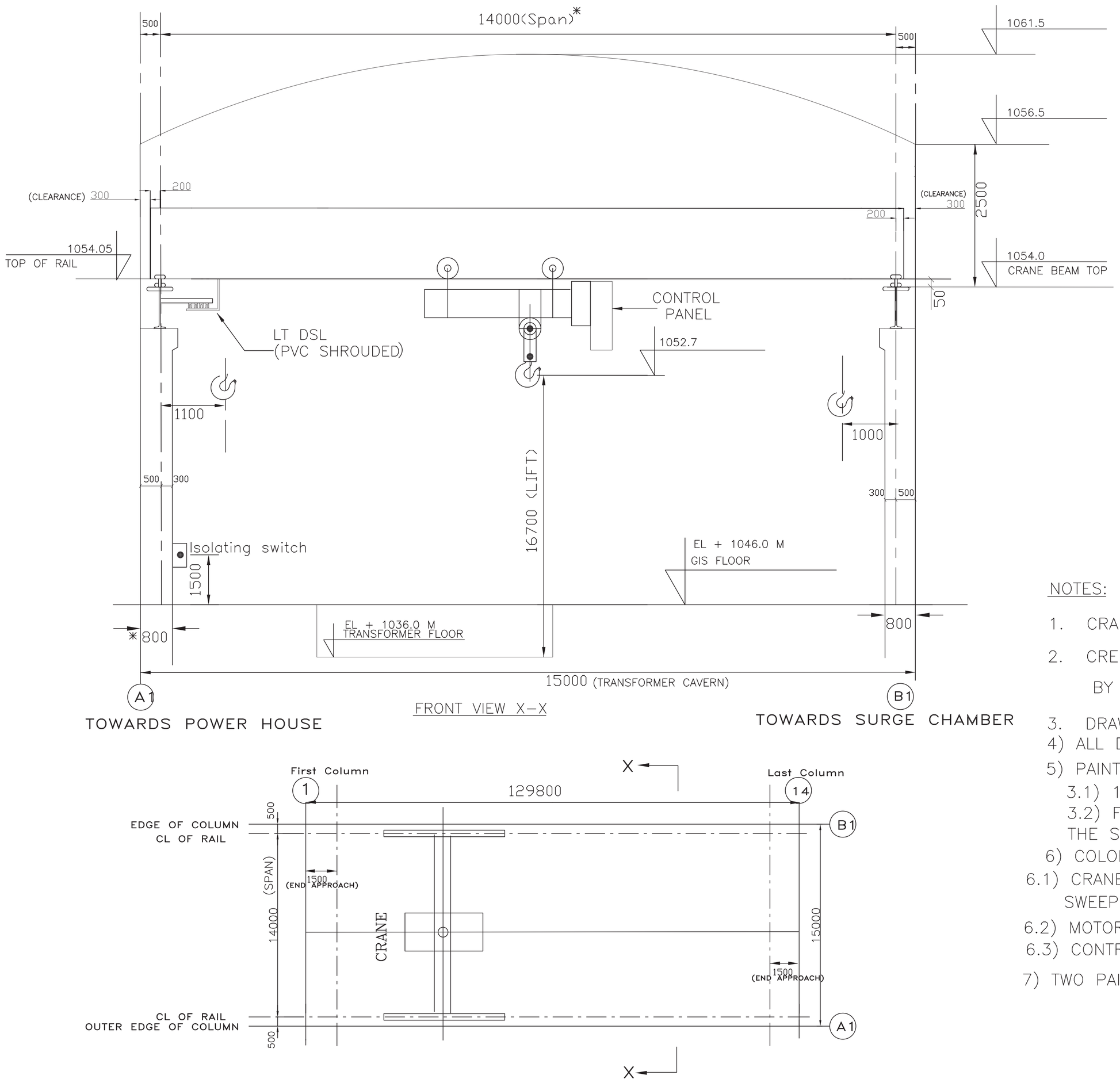
DRAWING NO PE-DG-413-501-A001

SHEET 1 OF 3 REV. 0

SIZE-A2

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
Fold-2

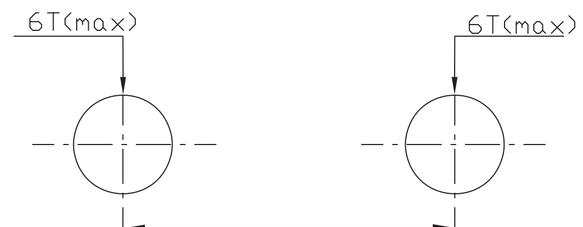
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
ALL DIMENSIONS ARE IN MM FIRST ANGLE PROJECTION
Fold-2 Fold-1
DRAWING No PE-DG-403-524-A001
3 4 5 6
Page 309



FRONT VIEW X–X

KEY PLAN

12.	CREEP SPEED SHALL BE ACHIEVED THRU' VVVF DRIVES	
11.	CLASS	M3
10.	DUTY	INDOOR DUTY
9.	QTY.	1 NO
8.	BAYLENGTH	129.8 MTRS
7.	LIFT	16.7 MTRS
6.	WHEEL LOAD (WITHOUT IMPACT) PER PAIR	6 T
5.	LT SPEED	30 MPM
4.	CT SPEED	15 MPM
3.	HOISTING	5.0 MPM
2.	SPAN	14.0+/–1 MTRS
1.	SAFE WORKING LOAD	12 T
SL NO.	TECHNICAL SPECIFICATIONS PARAMETERS	



(WITHOUT IMPACT)
LT WHEEL LOAD

NOTES:

1. CRANE CAPACITY SELECTED = 12 T
2. CREEP SPEED SHALL BE 0–100 % OF CORROSPONDING MAIN SPEED BY VVVF DRIVE.
3. DRAWING IS NOT TO THE SCALE.
4) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
5) PAINTING SPECIFICATION:–
   3.1) 1 PRIMER EPOXY ZINC COAT: 40 um.
   3.2) FINAL 2 COATS OF COLORED SOLVENT EPOXY PITCH: 2X150 um.
   THE SYSTEM MINIMUM THICKNESS SHALL BE 300 um.
6) COLOR SHADE:–
6.1) CRANE STRUCTURE, BOTTOM BLOCK ASSEMBLY, HOOKS AND END CARRIAGE SWEEP : LEMON YELLOW, SHADE 355 AS PER IS–5
6.2) MOTORS: STEEL GREY, SHADE 698 AS PER IS–5/ AS PER MANUFACTURER'S PRACTICE
6.3) CONTROL PANELS: STEEL GREY 698 AS PER IS–5/ AS PER MANUFACTURER'S PRACTICE.
7) TWO PAIRS OF WIRE ROPE SLINGS FOR 15 T LOADS SHALL BE PROVIDED.

COPY RIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED
it must not be used directly or indirectly in any way detrimental to the interest of the company.

COMPUTER FILE NAME : TAL5

CUSTOMER	THDC INDIA LTD, (THDCIL) VISHNUGARH PIPALKOTI HYDROELECTRIC PROJECT (4X111 MW)				
BHEL	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI	DEPT CODE		NAME	SIGN	DATE
			DRN	RG		20/05/16
			DESN	RG		20/05/16
			CHD	LJ/VK		20/05/16
			APPD	GB		20/05/16

TITLE

CRANE CLEARANCE DIAGRAM OF

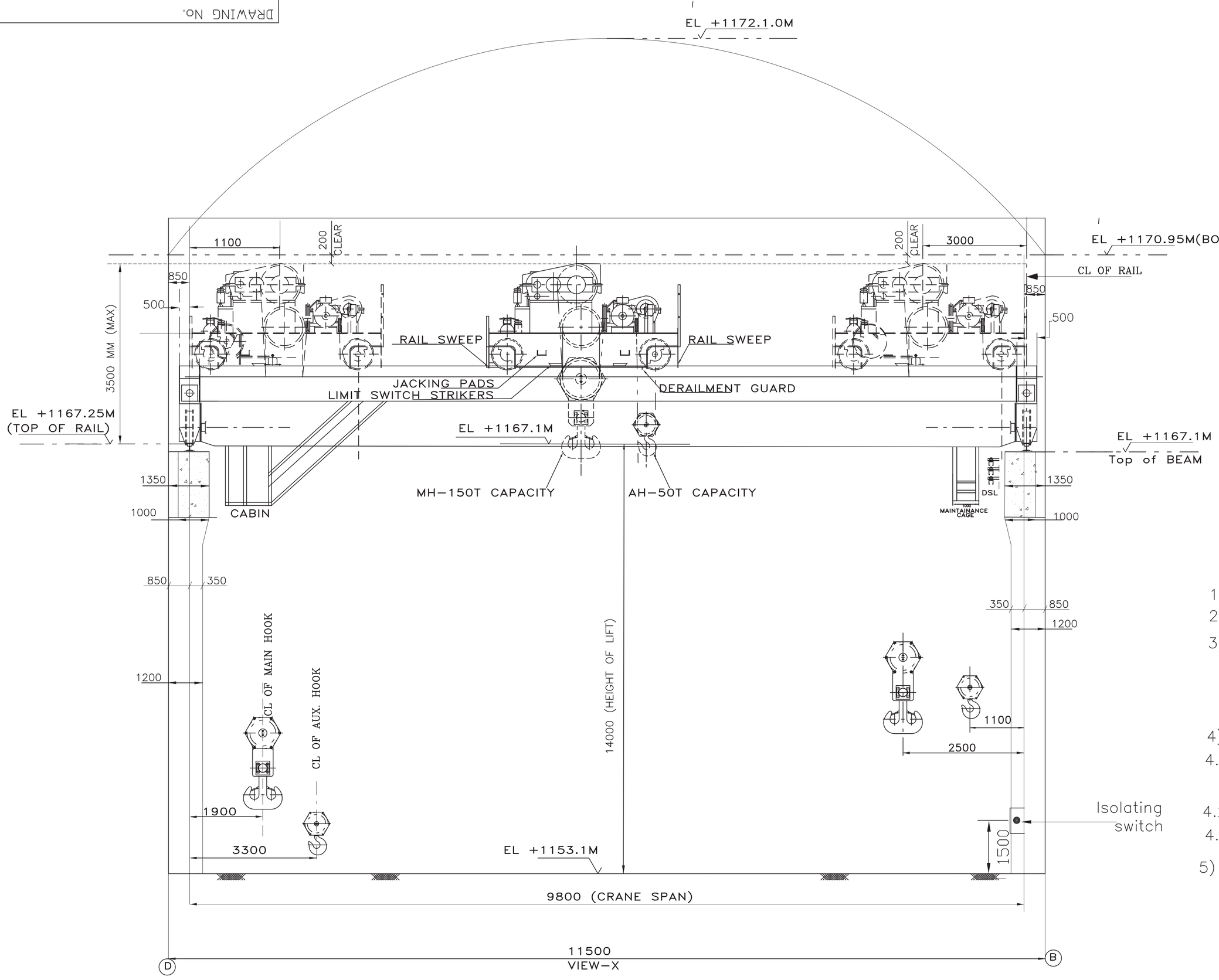
12 T SINGLE GIRDER E.O.T. CRANE FOR GIS HALL

DEPT.	SCALE	DRAWING NO.	
SIGN		PE–DG–413–501–A001	
DATE		SHEET 2 OF 3	REV. 0

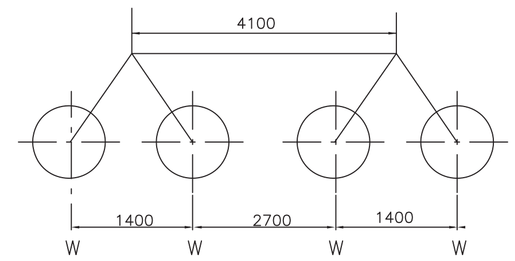
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
Fold-2

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
ALL DIMENSIONS ARE IN MM FIRST ANGLE PROJECTION

DRAWING NO.



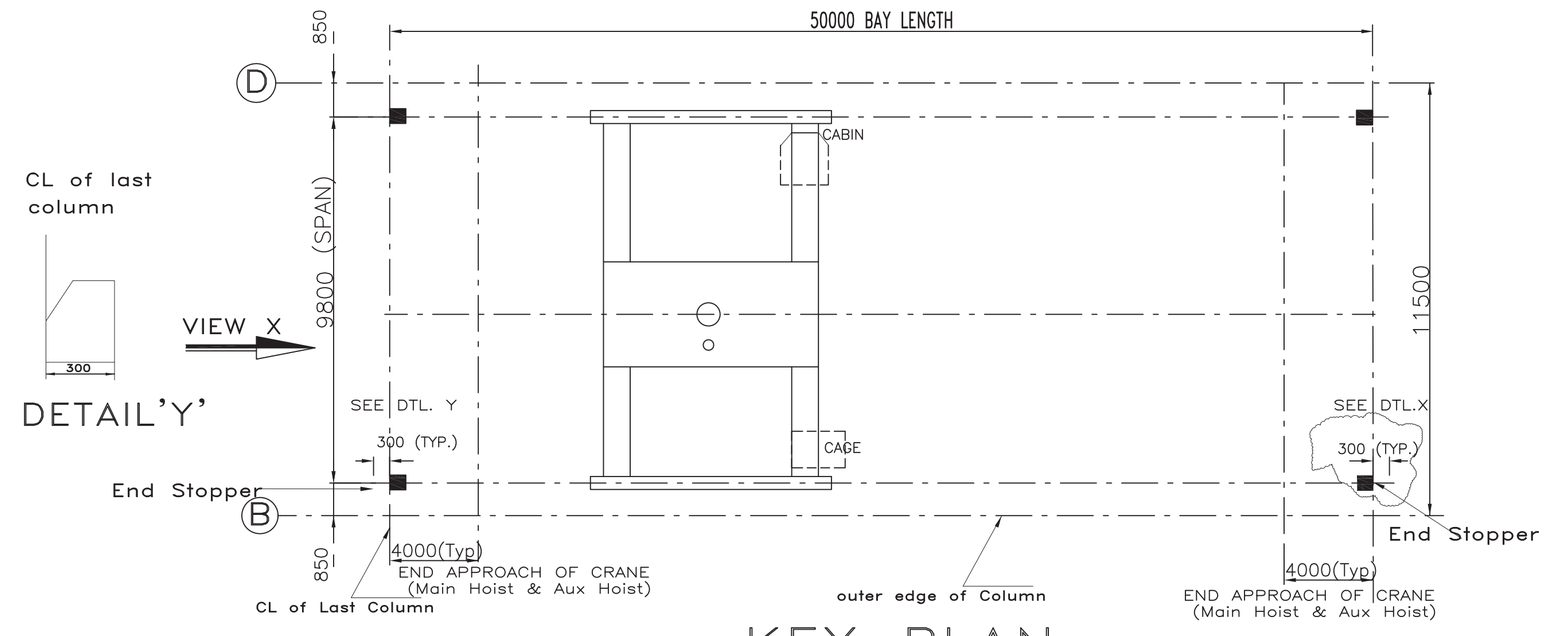
SL NO.	PARAMETER	VALUE
6.	CLASS	M3
5.	LT SPEED/CREEP SPEED	20.0/Ajustable from min. to max. (M/Min)
4.	CT SPEED/CREEP SPEED	10.0/Ajustable from min. to max. (M/Min)
3.	AH HOISTING/CREEP SPEED	8.0/Ajustable from min. to max. (M/Min)
2.	MH HOISTING/CREEP SPEED	1.0/Ajustable from min. to max. (M/Min)
1.	DESIGN STANDARD	IS 3177 & IS 807



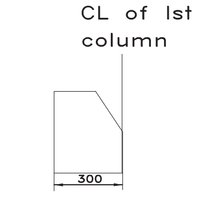
W = 36 TONS
WHEEL LOAD DIAGRAM WITHOUT IMPACT

NOTES

1) DRAWING IS NOT TO THE SCALE.
2) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
3) PAINTING SPECIFICATION:-
   3.1) 1 PRIMER EPOXY ZINC COAT: 40 um.
   3.2) FINAL 2 COATS OF COLORED SOLVENT EPOXY PITCH: 2X150 um.
   THE SYSTEM MINIMUM THICKNESS SHALL BE 300 um.
4) COLOR SHADE:-
   4.1) CRANE STRUCTURE, BOTTOM BLOCK ASSEMBLY, HOOKS AND END CARRIAGE SWEEP : LEMON YELLOW, SHADE 356 AS PER IS-5
   4.2) MOTORS: STEEL GRAY SHADE 698 AS PER IS-5/AS PER MANUFACTURER'S PRACTICE.
   4.3) CONTROL PANELS: STEEL GREY SHADE 698 IS-5/ AS PER PURCHASER PRACTICE.
5) TWO PAIRS OF WIRE ROPE SLINGS FOR DIFFERENCE LOADS (I.E. 65 T AND 150T SHALL BE PROVIDED.



KEY PLAN



REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

CUSTOMER	THDC INDIA LIMITED (THDCIL)
PROJECT	VISHNUGAD PIPALKOTI HYDROELECTRIC PROJECT (4X111MW)

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
	DRN	RG		01/06/16
	DESN	RG		01/06/16
	CHD	LJ/VK		01/06/16
	APPD	GB		01/06/16

CUSTOMER: THDC INDIA LTD.

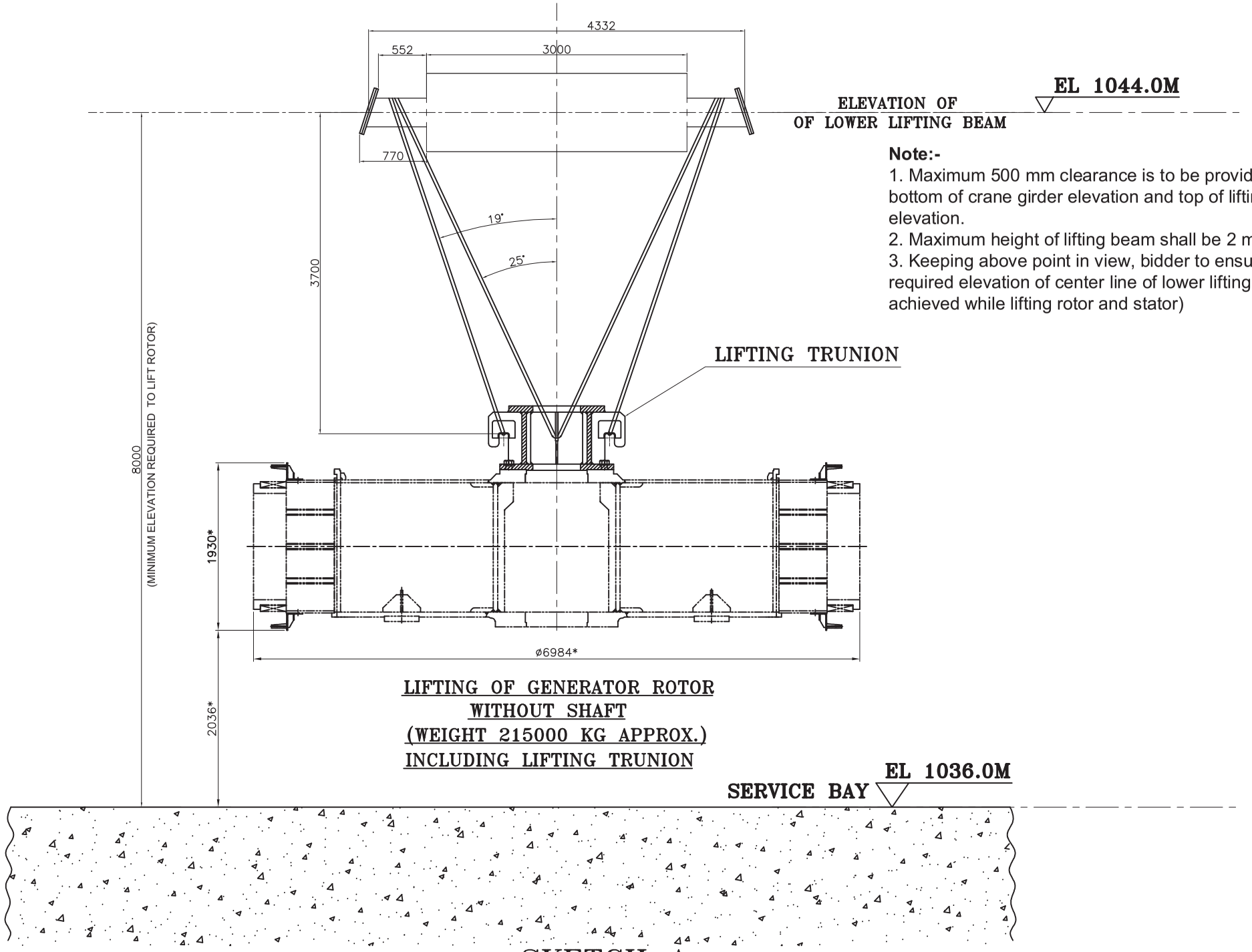
TITLE CRANE CLEARANCE DIAGRAM OF BUTTERFLY VALVE HOUSE 150/50T DOUBLE GIRDER EOT CRANE

DEPT. SCALE - NTS DRAWING NO PE-DG-413-501-A001
SIGN
DATE
SHEET 3 OF 3 REV. 0

SIZE-A2

COPY RIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED
it must not be used directly or indirectly in any way determental to the interest of the company.
COMPUTER FILE NAME : TAL5
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

ANNEXURE X- LIFTING DETAILS



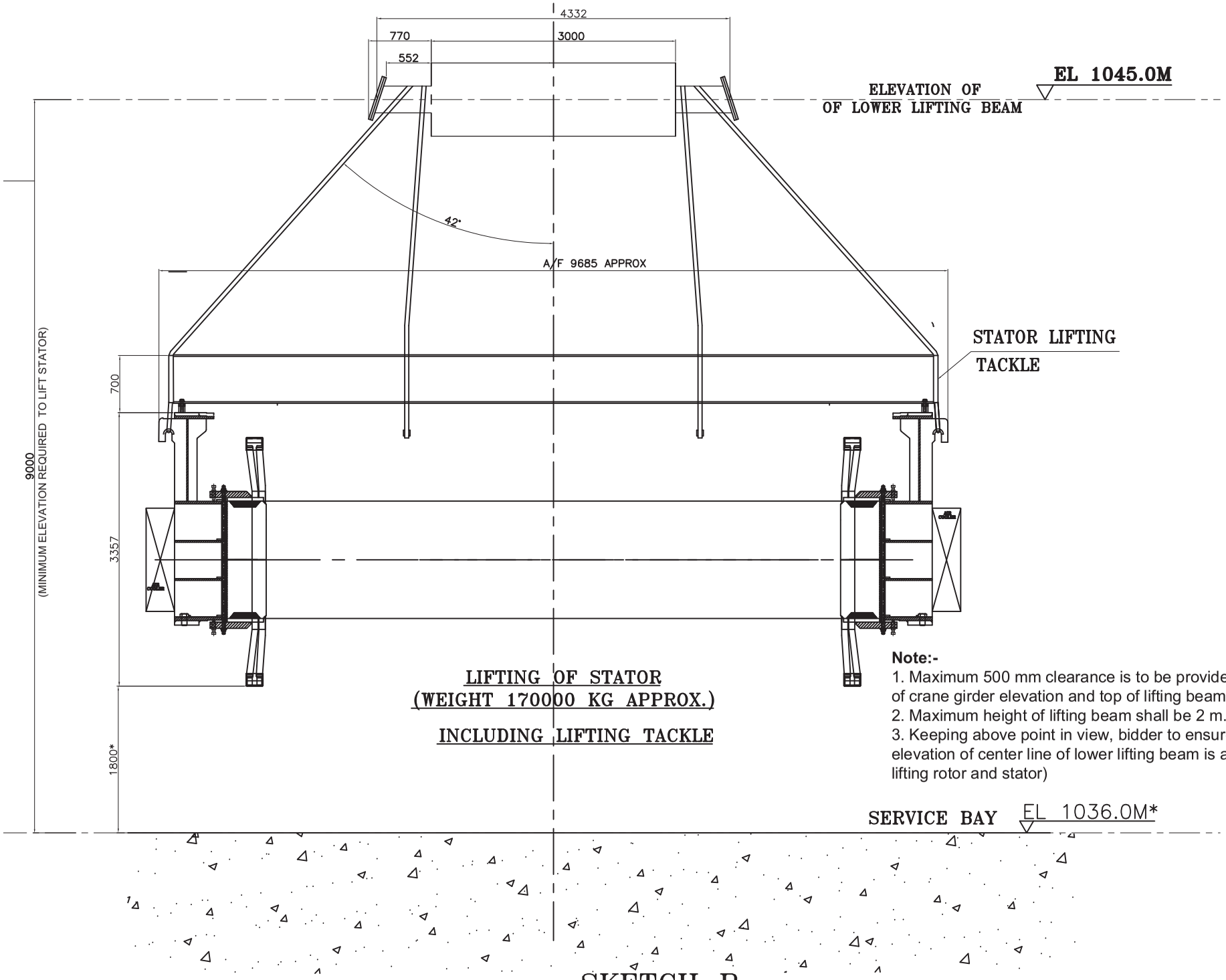
Note:-

1. Maximum 500 mm clearance is to be provided between bottom of crane girder elevation and top of lifting beam elevation.
2. Maximum height of lifting beam shall be 2 m.
3. Keeping above point in view, bidder to ensure that required elevation of center line of lower lifting beam is achieved while lifting rotor and stator)

LIFTING OF GENERATOR ROTOR
WITHOUT SHAFT
(WEIGHT 215000 KG APPROX.)
INCLUDING LIFTING TRUNION

SKETCH A

LIFTING DETAILS OF ROTOR



Note:-

1. Maximum 500 mm clearance is to be provided between bottom of crane girder elevation and top of lifting beam elevation.
2. Maximum height of lifting beam shall be 2 m.
3. Keeping above point in view, bidder to ensure that required elevation of center line of lower lifting beam is achieved while lifting rotor and stator)

SKETCH B

LIFTING DETAILS OF STATOR

ANNEXURE XI- SUPPLY PRICE BREAKUP

SUPPLY PRICE PERCENTAGE BREAKUP FOR POWER HOUSE CRANE

S. N.	Details of Works or Equipment/System	Qty. (LOT / Nos.)	Percentage (%) Break up proposed for billing purpose during contract for Supply
1.	Total lumpsum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight , unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for 2 nos. 150/50/10 T Power house area double girder EOT cranes with 30 M lift of main hook, 30 m lift of auxiliary hook, 18.8 M span complete with all accessories, isolating switch and power cable from isolating switch to DSL, Erection and commissioning spares for the total scope defined as per technical specification PE-TS-413-501-A001.	2 set.	87 %
2.	Total lump sum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight, unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for MS angle type runaway conductor / PVC shrouded bus bar type DSL for 113.44 M bay length for Power House area crane complete with all accessories for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	1.25 %
3.	Total lumpsum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight , unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for 113.44 M bay length Gantry rail for Power House area crane complete with all accessories for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	4 %
4.	Lump sum price of temporary cable for operation of crane during erection stage of the plant (equal to half the baylength plus 25 M) for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	0.5 %
5.	Lump sum price of Permanent cable for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	0.5%
6.	Lump sum price of Embedded parts for rail fixing arrangement and DSL fixing arrangement	1 set	2.0%
7.	Lump sum price of STORM BRAKE (LT hydraulic rail clamps/parking brakes) as per technical specification PE-TS-413-501-A001.	2 set	3.0 %
8.	Lump sum price of MAIN HOOK AND AUXILLIARY HOOK ASSEMBLY as per technical specification PE-TS-413-501-A001.	2 set	1.5 %
9.	Total lumpsum price for Maintenance tools and Tackles as per technical specification no. PE-TS-413-501-A001.	1 lot	0.25 %
NOTE: -These prices shall be used for billing purpose during contract stage.			

SUPPLY PRICE PERCENTAGE BREAKUP FOR BUTTERFLY AREA CRANE

S. N.	Details of Works or Equipment/System	Qty. (LOT / Nos.)	Percentage (%) Break up proposed for billing purpose during contract for Supply
1.	Total lumpsum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight , unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for 1 no. 150/50 T Butterfly valve area double girder EOT crane with 14 M lift of main hook, 14 m lift of auxiliary hook, 9.8 M span complete with all accessories, isolating switch and power cable from isolating switch to DSL, Erection and commissioning spares for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set.	87.75 %
2.	Total lump sum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight, unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for MS angle type runaway conductor / PVC shrouded bus bar type DSL for 50 M bay length for Butterfly valve area crane complete with all accessories for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	1.0 %
3.	Total lumpsum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight, unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for 50 M bay length Gantry rail for Butterfly valve area crane complete with all accessories for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	5.0 %
4.	Lump sum price of temporary cable for operation of crane during erection stage of the plant (equal to half the bay length plus 25 M) for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	0.5 %
5.	Lump sum price of Permanent cable for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	1 %
6	Lump sum price of Embedded parts for rail fixing arrangement and DSL fixing arrangement	1 set	3.0 %
7.	Lump sum price of MAIN HOOK AND AUXILLIARY HOOK ASSEMBLY as per technical specification PE-TS-413-501-A001.	1 set	1.5 %
8.	Total lumpsum price for Maintenance tools and Tackles as per technical specification no. PE-TS-413-501-A001.	1 lot	0.25 %
NOTE: -These prices shall be used for billing purpose during contract stage.			

SUPPLY PRICE PERCENTAGE BREAKUP FOR GIS HALL AREA CRANE			
S. N.	**Details of Works or Equipment/System**	**Qty. (LOT / Nos.)**	**Percentage (%) Break up proposed for billing purpose during contract for Supply**
1.	Total lumpsum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight , unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for 1 no. 12 T GIS Hall area single girder EOT crane with 16.7 M lift of main hook, 14 M span complete with all accessories, isolating switch and power cable from isolating switch to DSL, Erection and commissioning spares, tools and tackles, Embedded parts for rail fixing arrangement and DSL fixing arrangement for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set.	68 %
2.	Total lump sum firm price for design, engineering, manufacturing, inspection and testing, painting, supply/delivery duly packed at project site including freight, unloading, storage and handling at site in line with drawings/ documents/ test procedures approved by BHEL / Customer for MS angle type runaway conductor / PVC shrouded bus bar type DSL and Gantry rail for 129.8 M bay length for GIS hall area crane complete with all accessories for the total scope defined as per technical specification PE-TS-413-501-A001.	1 set	32.0 %
NOTE: -These prices shall be used for billing purpose during contract stage.			

Note:

1. The supply price percentage breakup is for progressive payment purpose only. This breakup does not relieve vendor from any contractual obligations and responsibilities with respect to condition of technical and commercial scope of contract.
2. Any item/quantity not specifically indicated in this break up but required as per system requirement, shall be supplied by vendor without any additional financial implication to BHEL.

VOLUME - IIB

SECTION – D

STANDARD TECHICAL REQUIREMENT

VOLUME - IIB

SECTION – D

STANDARD TECHNICAL REQUIREMENTS-

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.
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: Part 1: for working voltages up to and including 1100 volts.
xxx)	IS: 4289	Flexible cables for lifts and other flexible connections: 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.

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: 3613.4e

3.1.5 VOID

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.

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 4.9 mm (6 SWG). 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.

3.2.1.13 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 material which are superior for the intended service. But in all the cases, prior concurrence of the purchaser is must.

3.2.1.14 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.

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 number.

3.2.2.9 Maximum Span/ Depth ratio for Plate Girder shall be 25 or as per IS 807 latest edition.

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 1/6th of the span up to 20m, 3.5m for spans above 21m but less than 24.5m & 1/7th of span above 24.5m (as per IS 807 latest edition). 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**

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 1500 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 grove 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.

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. 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 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 in 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 ± 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 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-geared 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**

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 3% 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 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 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-54 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.
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.

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.

b) 60W bulkhead fittings with fluorescent lamp shall be used for lighting bridge platform.

c) Four (4) no.s - 250 W HPSV lamps shall be provided under the bridge as specified in the data sheet "A"

d) All lighting fixtures shall be mounted with anti-vibration mounting and shall be easily accessible for maintenance.

e) 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.

f) 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. Pendent push button station shall be earthed Separately.

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.

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

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

	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 ± 10V,
1 x Programmable current input 0(4) - 20mA
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

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

i) Input Voltage
ii) Input Frequency
iii) Output Frequency
iv) Output Power
v) Output Current

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

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

1.0 INTENT OF SPECIFIATION

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

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

2.0 CODES AND STANDARDS

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

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

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

3.0 DESIGN REQUIREMENTS

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

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

3.3 Starting Requirements

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

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

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

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

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

3.4 **Running Requirements**

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

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

3.5 **Stress During bus Transfer**

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

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

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

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

4.0 **CONSTRUCTIONAL FEATURES**

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

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

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

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

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

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

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise statedin Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

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

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

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

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

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

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

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

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

5.0 **INSPECTION AND TESTING**

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

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

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

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

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

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

VOLUME - III

DRAWINGS / DOCUMENTS TO BE SUBMITTED WITH THE BID

Bidder shall submit the following drawings / documents along with their bid:

a) Electrical load list duly stamped
b) Crane Clearance Diagram
c) Deviation schedule with reference to specific clauses of the specification along with reason for such deviation in the format given under Vol.-III
d) Un-priced copy of price format indicating quoted/ not quoted against each row/column
e) Copy of pre-bid clarifications, if any, duly signed & stamped
f) Signed/ Stamped copy of Compliance cum Confirmation Certificate (Vol.-III)

OFFER WILL BE CONSIDERED AS INCOMPLETE IN ABSENCE OF ANY OF ABOVE DOCUMENTS. DOCUMENT OTHER THAN ABOVE, IF ANY, SUBMITTED WITH THE OFFER WILL NOT FORM PART OF CONTRACT AND WILL NOT BE CONSIDERED FOR BID EVALUATION.

COMPLIANCE CUM CONFIRMATION CERTIFICATE

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

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', 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.

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.

PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

The bidder hereby clarifies that above mentioned are the only clarifications required on the technical specification for the subject package.

Signature: _____

Name: _____

Designation: _____

Company: _____

Date: _____

Company Seal

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Double Girder Crane for Power House Area		180 KW	S	1	0	D	S	N	I		In Power House							
Double Girder Crane for Butterfly valve area		130 KW	S	1	0	D	S	N	I		In Butterfly chamber							
Single Girder Crane for GIS Hall Area		20 KW	S	1	0	D	S	N	I		In GIS Hall							

Note: Signed and stamped copy of this electrical load data shall be furnished by bidder along with the bid. In event of ordering, above load data shall be considered as final and inputs for switchgear sizing shall be furnished to concerned Electrical agency based on this electrical load data. Hence, no changes in this load data shall be accommodated during detail engineering.

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	413	ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE	4x111 MW VISHNUGAD PIPALKOTI HEP	NAME		DATA FILLED UP ON	
	SYSTEM / S	DG EOT CRANE (50-150T)	SIGN.		DATA ENTERED ON	
	DEPTT. / SECTION	MAX/MATERIAL HANDLING	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

ANNEXURE-II: DEVIATION SHEET (COST OF WITHDRAWL)

PROJECT:-

PACKAGE:-

TENDER ENQUIRY REFERENCE:-

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									
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 format submitted with Priced bid, the cost of withdrawl of deviation shall be taken as NIL.
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 descrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.