SJVN ARUN-3 POWER DEVELOPMENT COMPANY Pvt. LTD. (SAPDC)

ARUN-3 HYDRO ELECTRIC PROJECT (NEPAL)
(4X225 MW)

TECHNICAL SPECIFICATION FOR TRANSFORMER CAVERN AREA 100/20T DOUBLE GIRDER EOT CRANE

SPECIFICATION NO.: PE-TS-437-501-A003 Rev 0

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

INDEX

SECTION	TITLE	PAGE NO.
I	SPECIFIC TECHNICAL REQUIREMENT	3
I	INTENT OF SPECIFICATION	4-5
I	PROJECT INFORMATION	6-15
IA	SPECIFIC TECHNICAL REQUIREMENT (MECHANICAL)	16-21
IA	QUALITY ASSURANCE AND INSPECTION REQUIREMENT	22-42
IA	CUSTOMER SPECIFICATION AND GENERAL TECHNICAL SPECIFICATION	43-136
IA	ANNEXURES	137
IA	-ANNEXURE I: MAKES OF SUB VENDOR ITEMS	138-148
IA	-ANNEXURE II: LIST OF MANDATORY SPARE	149-151
	-ANNEXURE III: LIST OF TOOLS AND TACKLES	152
IA	-ANNEXURE IV: PAINTING SPECIFICATION	153-154
IA	-ANNEUXRE V: DRAWING/ DOCUMENT SUBMISSION SCHEDULE	155-158
IA	-ANNEXURE VI: PACKING PROCEDURE	159-174
IA	-ANNEXURE VII: SUPPLY PRICE PERCENTACE BREAKUP	175-177
IA	-ANNEXURE IX: CRANE CLEARANCE DIAGRAMS	178-179
IA	-ANNEXURE XI: REFERENCE DRAWINGS -CROSS SECTION AND PLAN OF TRANSFORMER CAVERN AREA -TRANSFORMER CAVERN –L SECTION -POWER HOUSE GA PLAN AT 539.0 M	180-183
IB	SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)	184-185
IB	STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR	186
IB	DATASHEET OF MOTOR	187
IB	DATASHEET C OF MOTOR	188-189
IB	CUSTOMER SPECIFICATION FOR ELECTRICAL PART	190
IB	- CABLE AND CABLE TRAYS	191-206
IB	- 415 LTAC SYSTEM	207-226
IB	STANDARD MANUFACUTRING QUALITY PLAN FOR MOTORS (50 KW AND ABOVE RATING)	227-236
IC	DATA SHEET A	237-253
II	STANDARD TECHNICAL REQUIREMENT	254
II	-STANDARD TECHNICAL REQUIREMENT FOR DOUBLE GIRDER CRANE	255-270
II	-STANDARD TECHNICAL SPECIFICAITON FOR VVVF DRIVE	271-275
III	DOCUMENTS TO BE SUBMITTED BY BIDDER	276
III	LIST OF DOCUMENTS TO BE SUBMITTED ALONG WITH BID	277
III	PRE BID CLARIFICATION SCHEDULE	278
III	COMPLIANCE CUM CONFIRMATION CERTIFICATE	279-280
IIIC	ELECTRICAL LOAD DATA	281

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION I
SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION IA : Specific Technical Requirements (Mechanical)
SUB-SECTION IB : Specific Technical Requirements (Electrical)
SUB-SECTION IC : Data Sheet-A

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1. SCOPE OF ENQUIRY/INTENT OF SPECIFICATION

1.1 This specification includes, but not limited to SUPPLY PART, SERVICE PART (SUPERVISION & MAINTENANCE SERVICES) & MANDATORY SPARES comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants & consumables along with all accessories and spares for erection, start up and commissioning, forwarding, proper packing, shipment and delivery as per requirement given in NIT including warranty, supervision of erection and commissioning of cranes, supervision of load & overload testing at site, supervision of erection of sole plate, anchor bolts and required accessories for rail & DSL fixing, training of operators at site and maintenance service of 1 no. 100/320T EOT crane for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. **Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, supervision & maintenance services of the cranes and its accessories**.

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.

1.5 The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Section-III of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations, if any, should be very clearly brought out clause by clause in the enclosed deviation schedule along with cost of withdrawal; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, more stringent requirement as per the interpretation of the owner shall apply.

1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.11 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or customer including their consultant as interpreted by BHEL in the relevant context. For details refer the relevant clause in GCC.

1.12 Quality plan for reference is included in this specification to enable the bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the quality plan's minimum requirement during manufacturing and testing. Further all checks and tests indicated in QATR (customer's QAP) have to be followed.

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 (https://www.bhelpem.com/wrenchweb).

PROJECT INFORMATION

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION-1

GENERAL TECHNICAL SPECIFICATION

1.0 General

Arun-III Hydro-Electric Project in Nepal is contemplated for generation of hydro power with design energy of 3924 MU per annum in 90% dependable year. Project is proposed to be Run of River with Pondage Scheme.

1.1 Site Specific Information

1.1.1 Project Name

- Project Title:……..ARUN-III HEP
- Capacity:……4 X 225MW
- Owner:……..SAPDC

1.1.2 Location

The proposed project site is located at a distance of 50 km from Khandbari, the headquarters of Sankhuwa sabha District of Nepal. It is at about 240 km from Biratnagar and about 740 km from Kathmandu. The location details of the proposed project site are as indicated below:

- Latitude ……. .27º-30'N – 27 º -35'N
- Longitude …….. ...87º -12'E – 88 º-20'E
- Distance from Tumlingtar (domestic airport) town is…….About 68 km
- Distance of Kathmandu (international airport) from Tumlingtar…..About 660.km

1.1.3 Climatic Condition

Average max temp	:	30º C
Average Minimum Temp	:	20º C
Maximum river water temperature	:	25ºC
Minimum river water temperature	:	10ºC

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.1.4 Seismic Zone

The equipments shall be designed for operation in seismic zone four for earthquake resistance. The equipment and each part of it shall be strong enough and sufficiently well connected to resist total operating stresses resulting from forces in normal operation, abnormal condition and forces superimposed due to occurrence of earthquakes of intensity which cause a ground acceleration of 0.16 g in vertical direction and 0.24 g in the other horizontal directions.

1.1.5 Transportation

The nearest major airport is at Kathmandu which is at a distance of 740km from Project Site. Biratnagar is connected to Kathmandu by Road.

The major nearest seaport for the trans-shipment of heavy equipment to Nepal is Kolkata. Other sea ports for imported equipment would be Mumbai or Chennai as convenient. The two sea ports Mumbai & Chennai are connected to Kolkata and Jogbani by rail as well as roads.

Railway transport is available from Kolkata and other locations of Indian Cities to the Nepal-India border only. The broad gauge line from Kolkata ends at Jogbani, Bihar. All rail freight for Nepal has to be unloaded there. The distance of Kolkata by rail route is about 800 km. From Jogbani, the road distance to the projects sites via Biratnagar is about 300km.

Road access to Arun-3 project from Kolkata to Jogbani is 600km; from Biratnagar to Project Area via Hile is 300km. Total distance to project area from Kolkata is 900km.

Alternative route could be from Kolkata to Raxaul which is 800km, further from Birganj to Dhalkebar to Hile to Project Area which is 450km. Total distance Kolkata to Project Area is 1250km.

1.1.6 Transport Limitation

The transport limitation by road from Jogbani to the project site is the governing factor for determining permissible package size and weight.

The existing roads allow the transport of the packages of the following size and weight.

Size (in mm) (l x b x h)	9700 x 6000 x 6000*
Weight (Tonnes)	70R

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Heaviest package to be transported with suitable number of axle for safe transportation of consignment for 70R bridge capacity.
* Height from the ground

1.2 Salient features of Project

The salient features of Arun-3 HEP are as follows:

A.	**Hydrology**	
i.	Catchment Area	26747 KM^2
ii.	Probable Maximum Flood (PMF)	8880 cumec
iii.	Glacial Lake Outburst Flood (GLOF)	6830 cumec
B.	**Reservoir**	
i.	Maximum Water Level (MWL)	847.73 m
ii.	Full Reservoir Level (FRL)	845 m
iii.	Minimum Drawdown Level (MDDL)	835 m
iv.	Live Storage / Active Storage / Peaking Volume	5.65 MCM
v.	Inactive Storage (below MDDL)	8.29 MCM
vi.	Submergence Area at FRL	66.3 Ha
C.	**Dam**	
i.	Type of Dam	Concrete Gravity Dam
ii.	Dam top Level	El.849 m
iii.	River bed Level	El. 790 m
iv.	Dam Height above River bed	59 m
v.	Deepest Foundation Level	El.779 m
vi.	Height above deepest Foundation Level	70 m

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

vii.	Length of Dam at Top	197.30 m
viii.	Top Width of Dam	7 m
D.	**Diversion Arrangement**	
D.1	**Diversion Tunnel**	425 m long, 11 m diameter circular-shaped to divert 1300 cumecs
D.2	**Upstream Coffer Dam**	
i.	Type	Concrete Dam
ii.	Top Level	El. 817 m
iii.	Height of U/s Coffer Dam	26 m
iv.	Length	120 m
D.3	**Downstream Coffer Dam**	
i.	Type	Rock fill Dam
ii.	Top Level	El. 797.5 m
iii.	Height of D/s Coffer Dam	8.5 m
iv.	Length	92 m
E.	**Spillway**	
i.	Design Flood	PMF-8880 cumec GLOF -6830 cumec
ii.	Energy Dissipation System	Trajectory Bucket type
iii.	i)Sluice spillway No. Size ii)Overflow spillway No. Size	 6 9.0 m (W)X 14.0 m (H) 1 5.0 m (W)X 5.0 m (H)
iv.	Crest Level	El 808m-Sluice type

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

			El 840m-Overflow spillway	
F.	**Power Intake**			
i.	No. & Type		2 Nos., Straight intake with bell mouth	
ii.	Invert Level		El.819m	
iii.	Top Level		El.849m	
G.	**Intake Tunnels**			
	No. & Type		2 Nos., 7 m diameter, horse-shoe shaped	
	Length		181.50 m & 173.30 m	
	C.L. of Intake Tunnel		El 822 m	
H.	**Head Race Tunnel**			
i.	Diameter and shape		9.5m circular	
ii.	Length		11778.68 m	
iii.	Design Discharge		344.68 cumecs	
iv.	No. of Adits & size		4 Nos.,7 m X 7 m D - shaped	
v.	Adit	Adit Length	RD of HRT	Distance between Adits
	1	691.32m	1052.51 m	
	2	768.39m	5148.20 m	4095.69 m
	3	386.13 m	8205.02 m	3056.82 m
	4	365.32 m	11727.41 m	3522.39 m
I.	**Surge Shaft**			
i.	Size & shape		Open to sky, Restricted Orifice 1No., 24.0m diameter, Circular	
ii.	Height		149 m	

iii.	Top Level		El 940.00 m	
iv.	Gates, No. & Size		2 Nos., 5.5m (W)X 7.5m (H)	
v.	Surge Levels			
	Load case 100-0-0 (up)		El. 879.75 m	
	33-100-0 (up)		El. 863.35 m	
	100-0-33 (down)		El. 826.79 m	
	10-100-100 (down)		El. 801.61 m	
J.	**BUTTERFLY VALVE CHAMBER - UNDER GROUND**			
i.	Size		62 m (L) x 12 m (W) x 21 m (H)	
ii.	Butterfly valve		2 Nos. 5.5 m dia.	
K.	**Pressure Shaft**			
i.	Nos.		Underground, 2 Nos.	
ii.	Type & Size		Circular, each 5.5 m dia bifurcating into two nos of 4.0 m diameter to feed four units	
iii.	Length of pressure shafts 1 and 2			
	Pressure shaft-I	447.413 m	Pressure shaft-2	411.681 m
	Branch 1	82.208 m	Branch 3	55.970 m
	Branch 2	58.82 m	Branch 4	54.358 m
L.	**POWER HOUSE COMPLEX**			
i.	Power House Cavern		Underground on Left bank	
ii.	Installed capacity		900 MW	
iii.	No. of units		4	
iv.	Unit Capacity		225 MW	
v.	Size of Power House Cavern		179.50m (L) x 22.5m (W) x 49.5m(H)	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

vi.	Centre line of Turbine	EL. 525 M
vii.	MIV Floor level	El 520.5M
viii.	Turbine Floor Level	EL. 529 M
ix.	Generator Floor Level	EL. 534 M
x.	Machine Hall Level	EL. 539 M
xi.	Service Bay Level	EL. 539 M
xii.	Dewatering Gallery	EL. 512.50 M
M.	**TURBINE**	
i.	Type	Vertical Francis
ii.	Number	4
iii.	Rated Capacity	225 MW
iv.	Head Loss for calculation of Design net head	21.46 m
v.	Design Net Head	286.21 m
vi.	Rated Discharge	86.17 m3/Sec
vii.	Speed	250 rpm
N.	**GENERATOR**	
i.	Type	Vertical shaft, Francis turbine driven, alternating current synchronous generators
ii.	Number	4
iii.	Rated Output	250 MVA
iv.	Continuous overload output (110% of rated)	275 MVA
v.	Rated Voltage	15.75 kV
O.	**Bus Duct**	4 Nos. The bus duct shall be natural air cooled and rated for 17.5 kV and

		shall be designed to carry 10.5 kA continuous current.
P.	**UNDERGROUND TRANSFORMER CAVERN**	
i.	Size	146.14m (L) x 16 m(W)x 23m(H)
ii.	Transformer Type	Single Phase
iii.	Number and rating	13 nos. (including 1 spare), 15.75/420/√3kV, 50Hz, 92MVA
iv.	Transformer Hall level	El. 552 m
Q.	**Switchyard & Transmission**	
i.	Type of Switching	Gas Insulated Substation and Pothead Yard
ii.	Size	207m (L) x 106m (W)
iii.	Switchyard level	El. 557 m
iv.	Number of bays	11 Nos. (4 Nos. GT Bays + 2 Nos. Line Bays + 2 Nos. Line Reactor Bays + 2 Nos. Bus Reactors Bays+ 1 No. Bus Coupler Bay)
v.	Transmission System	400kV Arun III HEP – Muzzafarpur via Dhalkebar D/c Quad Moose Lines with LILO of both circuits at Dhalkebar 400/220kV substation (310kms)
R.	**Draft Tube Gate**	4 Nos. fixed wheel type of size 5m(W) X 5.5m(H)
S.	**Tail Race**	
i.	Type and size	Circular shaped, 10 m
ii.	Length of TRT	108.12 m
iii.	Minimum Tail Water Level	El 533m
iv.	Maximum Tail Water Level	El 535m
v.	Average Tail Water Level	El 534m

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.2.1 Power System Study Report

Power system study report containing various data on Generator, Governor, Excitation System, Insulation coordination etc. shall be shared with the successful bidder for reference after award of the contract**.**

1.3. Water Sample Details

Petro graphic Analysis Report of silt in the river at Project site is attached as Annexure - B of this Section.

1.4. Operating Pattern of the Plant

During High flow season (i.e. from June to September), Plant shall be operated as base load station. However, during lean flow season (i.e. from December to March), it shall be operated as peaking Plant.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION IA
SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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 CRANE with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the EOT crane complete for efficient operation shall also be under the bidder's scope of work.

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

1.1.3. One number 100 T/20T Double Girder Crane for Transformer cavern 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, RRC, panels etc.(as per data sheet-A)
f. PVC insulated shrouded bus bar Cu conductor type DSL along with insert plates (fixing plates for DSL) to be mounted at civil girder.
g. Earthing arrangement
h. Fill of lubricant till commissioning of crane
i. Painting of cranes and accessories
j. Permanent cables for crane as per datasheet A
k. Temporary cables for operation of crane during erection stage of the plant (30m)
l. Rail complete with sole plates, anchor bolts, clamps etc. including all accessories and end stopper
m. Maintenance tools & Tackles
n. Erection & Commissioning spares
o. Mandatory Spares
p. Main Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the crane.
q. Pair of wire rope slings as given below:-
   Six (6) pairs of wire rope slings for different loads (i.e. 100T, 60T, 40T, 20T, 10T, 5T) upto respective rated capacity for Transformer cavern area crane.
r. A storage rack for safe keeping of the slings separately for EOT crane for Transformer cavern area

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.1.4 **Maintenance Tools and Tackles**

As per Annexure III, section-IA 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 requirement of mandatory spare parts is listed in Annexure –II section-IA 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 along with ten (10%) percent excess quantity. The bidder shall deliver to the Owner all equipment complete with initial fill of fluids, grease or lubricants, in drums / containers. Bidder shall supply minimum following spares

i)	Oil seal for each gear box	1 Set
ii)	Indicating Lamps 1 no. of each type	1 Set
iii)	Push Button 1 no. of each type	1 Set
iv)	Aux. contactor 1 no. of each size	1 Set
v)	Limit switches- 1 no. of each type	1 Set
vi)	Any other spare/s, as per experience of bidder	

Note:

a. Any spare, not quoted by bidder, but required during commissioning shall be supplied by bidder without any additional cost to purchaser.

b. One set means 100% requirement of one crane.

1.1.7 Any supplies to be done under warranty clause & any other clause of NIT, **GCC, SCC** as relevant to the package

1.1.8 Packing as per Annexure VI, forwarding and transportation to delivery address as per SCC.

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

1.2.1. Detailed Erection and commissioning procedure shall be submitted by successful bidder for carrying out the erection and commissioning at site by BHEL.

1.2.2. Scope of Supervision for Erection & commissioning: Tentatively following visits shall be planned by site team which shall be as follows: -

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

a) One visit for supervision for erection of sole plate and anchor bolts for rail fixing and insert plates for DSL fixing for Transformer cavern area Double Girder crane.

b) Ono visit for Supervision of Erection and commissioning of Transformer cavern area crane.

c) One visit for Supervision of load and overload tests for Transformer cavern area Double Girder crane.

d) Any additional visit as per requirement of BHEL site office during erection of equipments.

Note: Bidder shall be informed at least 10 days in advance for the requirement of visit at site. Visiting team shall consist of one or two expert of bidder as deemed necessary by them.

1.2.3. Scope of Maintenance Services: Maintenance services shall commence after commissioning and load testing of crane at site. Maintenance services shall comprise of following

Bidder may be called for maintenance services for either of the cases:

a) Routine maintenance including spare for wear and tear

b) Breakdown maintenance

c) For checking healthiness of crane as per requirement of BHEL site office

a) Routine maintenance.

i- Frequency of visits: 1 visit in every 6 months (Tentative 4 nos. visits after load/ overload testing).

ii- Any tools and tackles, consumables like oil, grease etc., spares required for replacement due to wear & tear shall be in bidder's scope and bidder has to ensure availability of the same before their arrival at site.

iii- Healthiness of crane is to be ensured.

b) Breakdown maintenance:

i- Bidder to attend the crane within 72 hours of intimation by deputing expert. Any damaged item shall be replaced by bidder under warranty condition as defined under scope of supply.

ii- Any tools and tackles, consumables like oil, grease etc., spares required for replacement due to wear & tear shall be in bidder's scope.

iii- Healthiness of crane is to be ensured.

d) For checking healthiness of crane as per requirement of BHEL site office

i- Any tools and tackles, consumables like oil, grease etc., spares required for replacement due to wear & tear shall be in bidder's scope and bidder has to ensure availability of the same before their arrival at site.

ii- Healthiness of crane is to be ensured.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Note: Bidder shall be informed at least 10 days in advance for the requirement of visit at site (Except for breakdown maintenance). Visiting team shall consist of one or two expert of bidder as deemed necessary by bidder.

1.2.4 Training to customer's O&M staff at site during visit for supervision of E&C and maintenance services.

1.2.5 Bidder has to facilitate customer / BHEL to obtain statutory clearance / licensee for radio remote control system from statutory authority.

1.3.0. **PAINTING & COLOUR SCHEME**

As per Annexure IV, section-IA of this specification

2.0.0. **Works Excluded**

a) Erection and commissioning of cranes

b) Uncabled supply feeder shall be provided by BHEL/ customer (as per electrical scope matrix of section IB).

c) Gantry Girder (RCC)

d) Dead load for load/overload testing at site

e) Storage, unloading and transportation at site

f) Cradle for load/overload testing at site

g) Erection hook

OTHER REQUIREMENTS:

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 Sec 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**.**

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

5.0.0. Makes of Sub - Vendor items

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

6.0.0 Parameter and tolerances for structural assembly including rail shall be as per the relevant standards which shall be ensured under supervision of bidder's representative.

7.0.0. Performance Test requirement

EOT crane along with its drives, controls and other accessories shall be checked for the rated capacity against the rated speed of motions and for the service conditions specified.
The bidder shall have the full responsibility for the safe and efficient operation of the crane with associated accessories as a single unit. If the site performance tests indicate the failure of any of the components to achieve the desired performance, the deficiency shall be made good at bidder's cost. Performance test shall be carried out each time after the rectification /modification is carried out. Performance test of the crane shall include load tests and speeds in various motions at site which shall be done in supervision of bidder.

7.1.0 Testing at works

Refer section IA: QUALITY ASSURANCE AND INSPECTION REQUIREMENT

7.2.0 Testing at site (shall be done in supervision of bidder)

7.2.1 Completely assembled crane at site shall be check for misalignment of gears, shafts and other items. Following minimum tests shall be conducted on the crane at the site under supervision of bidder's representative

i. Deflection test of bridge girder at rated load. Crane shall rest on centre line 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

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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION IA

QUALITY ASSURANCE AND INSPECTION REQUIREMENT

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Manufacturing Quality Assurance Test Requirements

	Project Name: Arun - 3 HEP (4x225 MW)	**Doc. No.** QAI/A/M/EM/EOT/01	
	Item Description: EOT Crane		
Sr. No.	**Component, Operation & Characteristics**	**Applicable Standard**	**Remarks**
1	2	3	4
	EOT CRANE		
1	**Incoming Material**		
1.1	**Box Girder, End carriage, Crab Frame, Bed frame, Load frame / cradle.**		
	Chemical Analysis & Mechanical Properties	TS/DRG/ REL.STD.	V
	UT of plates	TS/DRG/ REL.STD.	V
	Dimensional Check	TS/ DRG	V
	Material Identification & transfer stamping	TS /Manufacturer standard practice / REL. STD.	V
1.2	**Casting/plate for Rope Drum**		
	Chemical Analysis & Mechanical Properties	TS/DRG/ REL.STD.	V
	Heat Treatment of Casting	TS/DRG/ REL.STD.	V
	UT of casting/plate	TS/DRG/ REL.STD.	V
	Dimensional Check	TS/ DRG	V
	Material Identification & transfer stamping	TS /Manufacturer standard practice / REL. STD.	V
1.3	**Wheels**		
	Chemical analysis & Mechanical Properties including hardness	TS/DRG/ Rel. Std.	V
	UT & DPT	TS/DRG/ Rel. Std.	V
	Dimensional Check	TS/DRG/ Rel. Std.	V
	Heat Treatment	TS/DRG/ Rel. Std.	V
1.4	**Wire Rope, Slings**		
	Identification & Grade	TS/DRG/ Rel. Std.	V
	Dimensional Check	TS/DRG/ Rel. Std.	V
	Check for twist, kinks, proper thimble end connection & splicing	TS/DRG/ Rel. Std.	V
	Braking Strength	TS/DRG/ Rel. Std.	V
1.5	**Gear Box casing**		
	Chemical analysis & Mechanical Properties	TS/DRG/ Rel. Std.	V
	Surface condition	TS/DRG/ Rel. Std.	V
1.6	**Gears, pinions, shaft, coupling shaft & Axles**		
	Chemical Composition & Mechanical Properties including Hardness	TS/ DRG/REL.STD	V
	Dimensional Check	TS/ DRG/REL.STD	V
	UT after proof machining	ASME Sec VIII & V	V
	DP Test on teeth	ASME Sec VIII & V	V
	Heat Treatment	TS/ DRG/REL.STD	V
1.7	**Bearings**		
	Make & type	TS/DRG/ Rel. Std.	V
1.8	**Lifting Hook and Block**		
	Mechanical Properties on integral test bar Chemical analysis	TS/DRG/ REL.STD.	V
	Heat Treatment	TS/ DRG	V
	UT on raw material of Hook	TS/DRG/ Rel. Std.	V
	Forging operation of Hook	TS/DRG/ REL.STD.	V
	Proof Load Test	TS/DRG/ REL.STD.	W
	UT & MPI after proof load test (UT on shank portion only)	TS/DRG/ ASME Sec- VIII & V	W
	Material Identification	TS/DRG/ REL.STD.	V
1.9	**Rails (CT rail as well as run way rails)**		
	Chemical Composition & Mechanical Properties including Hardness	TS/DRG/ Rel. Std.	V
	Dimensional check	TS/DRG/ Rel. Std.	V
1.10.	**Pulleys, brake drums, coupling & other major steel casting & forging**		
	Chemical Composition & Mechanical properties	TS/DRG/ Rel. Std.	V
	Hardness except pulleys	TS/DRG/ Rel. Std.	V
	Final Dimensional Check	TS/DRG/ Rel. Std.	V
	DPT in groove after machining of pulleys	TS/DRG/ Rel. Std.	V
1.11	**Electric Motors**		
	Routine Test & Verification of IP class	TS/DRG/ IS:325	V
	Type test	TS/DRG/ IS:325	V
1.12	**Master controllers Radio Remote, Pendant Controller, if applicable**		
	HV, IR, Functional tests	TS/DRG/ Rel. Std.	V

1.13	**Brakes**		
	Routine Test	TS/DRG/ Rel. Std.	V
1.14	**Resistance Box if applicable**		
	IR Test & HV Test	TS/DRG/ Rel. Std.	V
	Temperature Rise	TS/DRG/ Rel. Std.	V
	Measurement of Resistance	TS/DRG/ Rel. Std.	V
	Verification of IP class	TS/DRG/ Rel. Std.	V
1.15	**Power & Control Cables**		
	Acceptance Test& Routine Test	TS/DRG/ Rel. Std.	V
1.16	**Limit switch**		
	HV, IR & Functional Check & Verification of IP class	TS/DRG/ Rel. Std.	V
1.17	**Current collector arm, if applicable**		
	Dimensional check	TS/DRG/ Rel. Std.	V
1.18	**DSL guard, if applicable**		
	Dimensional check	TS/DRG/ Rel. Std.	V
1.19	**Sockets for wire rope**		
	Destructive tensile test in which rope shall fail first than the socket or joints	TS/DRG/Rel. Std.	V
1.20.	**Sole Plates & Clamps**		
	Chemical composition and Mechanical Properties.	TS/DRG/Rel. Std.	V
	NDT & Diemsions.	TS/DRG/Rel. Std.	V
2	**In process Inspection**		
2.1.	**Welding**		
2.1.1	**Butt weld, if any, in Box Girder, End carriage, Crab Frame, Rope Drum, Gear Casing, Load Frames / Cradle**		
	DP/MPI test after root run.	ASME Section V & VIII/BS 5135/DRG/TS	V
	RT.	ASME Section V & VIII/BS 5135/DRG/TS	V
	UT, DPT & MPI.	ASME Section V & VIII/BS 5135/DRG/TS	W
2.1.2	**Fillet Welds in Box Girder, End carriage, Crab Frame, Rope Drum, Gear Casing, Load Frames / Cradle.**		
	NDT of all fillet weld joint as per drawing or MPI / DP of all fillet joints if it is not specified in drawing. NDT of inaccessible weld joints in Box Girder (before closing) shall be witnessed by SAPDC.	ASME Section V & VIII/BS 5135/DRG/TS	W / V
2.1.3	All weld joints: Visual Examination for final weld appearance, cracks, undercut, Excess reinforcement, burn through or excess penetration, root concavity , non-uniform width of fillet weld joint, distortion & misalignment.	ASME Section VIII &V/DRG	W / V
2.1.4	Stress relieving of assemblies /sub-assemblies / item (rope drum, gear box casing & rope drum) after welding as per DRG.	TS/ASME Section V&VIII/ DRG	V
2.1.5	Dimensional check of weld joints/ Weld size (Weld size shall be checked with universal weld gauge).	ASME Section VIII/DRG	W / V
2.1.6	Welding & welder records to be maintained for Box Girder, End carriage, Crab Frame, Rope Drum, Load Frames / Cradle in weld Log book.	Relevant standard ASME/IS/IEC	V
2.2	**Machining: Machined Components**		
	Visual examination	TS/DRG/ Rel. Std.	V
	Dimensional check	TS/DRG/ Rel. Std.	V
	Surface finish	TS/DRG/ Rel. Std.	V
	Material traceability control	TS/DRG/ Rel. Std.	V
2.3	**Box Girder**		
	Dimensional check including camber, verticality & bend	TS/ DRG/ IS 3177/ IS 807	W for girder before closing.
	Material Identification & transfer stamping	TS/DRG/ Rel. Std.	V
2.4	**End carriage**		
	Dimensional check	TS/ DRG/ IS 3177/ IS 807	V
2.5	**Rope Drum**		
	Dimensional check	TS/ DRG/ IS 3177/ IS 807	V
	DP test after machining	TS/ DRG/ ASME	V
	Visual check for surface defects after machining	TS/DRG/ Rel. Std.	V
	Stress relieving after welding, if applicable	TS/ASME Section V&VIII/ DRG	V
2.6	**Gear Box casing**		
	Dimensional check	TS/ DRG/ IS 3177/ IS 807	V
	Stress relieving after welding	TS/ASME Section V&VIII/ DRG	V
2.7	**Platforms, LT Frames, Hand Railings, Crab Assembly**		

	Dimensional Check	TS/DRG/ Rel. Std.	V
2.8	**Gear Box Assembly and Idle Running**		
	Check for Oil Leakage	TS/DRG/ Rel. Std.	V
	Noise Level	TS/DRG/ Rel. Std.	V
	Backlash, Meshing of gear & pinions teeth	TS/DRG/ REL.STD.	V
	Rise in Temperature after 2 hrs of running	TS/DRG/ Rel. Std.	V
2.9	**Brakes**		
	Check for alignment, tightness and capacity	TS/DRG/ Rel. Std.	V
2.10.	**Cabin, if applicable**		
	Dimensional check	TS/DRG/ Rel. Std.	V
2.11	**Bridge with LT**		
	Dimensions, wheel level alignment	TS/DRG/ Rel. Std.	V
2.12	**Crab assembly**		
	Dimensions, wheel level alignment.	TS/DRG/ Rel. Std.	V
3	**Final Inspection (EOT Crane at Manufacturer's Works)**		
	Overall inspection of crane, dimensions, Span, Diagonal Dimensions check, clearances, ratings, hook reaches, Equipment Layout on bridge platform, skewness, cambering of girder. Visual & Dimension check of Load frame / cradle. Visual & dimension check of slings.	TS/ DRG/ IS 3177/ IS 807	W
	Electrical & Electronic Panels.	TS/ DRG/ IS 3177/ IS 807	W
	Insulation Test on Electrical Components of Crane.	TS/ DRG/ IS 3177/ IS 807	W
	No Load tests and load tests as per Technical Specification	TS/ DRG/ IS 3177/ IS 807	W
	No load Running of Machinery for Direction & Speed, Check of working range.	TS/ DRG/ IS 3177/ IS 807	W
	No load Test of Hoists, CT, LT, Speed & Current Measurement. Testing of fault panel functions, Test of emergency stop at no load.	TS/ DRG/ IS 3177/ IS 807	W
	SWL test: Hoisting, Travel operation, Speed, Current & Deflection Measurement.	TS/ DRG/ IS 3177/ IS 807	W
	Overload Test at 125% of SWL: Check for Hoisting & Travel operation.	TS/ DRG/ IS 3177/ IS 807	W
	Simultaneous Operation of main and auxiliary Hoists.	TS/ DRG/ IS 3177/ IS 807	W
	Braking Test.	TS/ DRG/ IS 3177/ IS 807	W
	Functional check for emergency stop, limit switch operation & overload protection.	TS/ DRG/ IS 3177/ IS 807	W
	Oil leakage check in gear box.	TS/ DRG/ IS 3177/ IS 807	W
	Visual inspection of Hook & accessible weld joints after load test.	TS/ DRG/ IS 3177/ IS 807	W
	DP test of Hook & accessible weld joints after load test.	TS/ DRG/ IS 3177/ IS 807	W
	Measurement of throat opening of hook after load test.	TS/ DRG/ IS 3177/ IS 807	W
	Other tests as per Technical Specification		
	De-energized tests as per TS.	TS/ DRG/ IS 3177/ IS 807	W
	Energized tests as per TS.	TS/ DRG/ IS 3177/ IS 807	W
4	**Cleaning, Coating and Painting**		
	Surface Preparation.	TS/ DRG	V
	Check for Paint thickness and adhesion test.	TS/ DRG	V

LEGENDS

TS: TECHNICAL SPECIFICATION	REL. STD.: RELEVANT STANDARD
W: CUSTOMER HOLD POINT (CHP)	DRG: DRAWING
V: VERIFICATION OF REPORT/TEST CERTIFICATE	

NOTES

1	Any test at any stage not covered in Quality Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification

1.1.0. Inspection and Testing

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

1.1.1. Inspection and testing at Manufacturer's works

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

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

STAGE INSPECTION

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

i. All test certificates shall be in original and legible. Photocopies certified by Mill/ manufacturer of raw material used, are acceptable.

ii. For tensile testing of hooks/ forgings, samples shall be drawn from the full cross section of the shank diameter of hooks/ forgings Samples forged to reduced cross section for testing purposes is not acceptable. **Hooks shall be manufactured from Blooms, billets, rounds by forging with forging ratio of at least 3:1. Hooks manufactured from plates are not acceptable.**

iii Radiographs shall be inspected to a sensitivity of 2%.

iv Ultrasonic test on forgings and casting of critical components like cross head (hook suspension block), Hooks, Shafts, Axles, Gears, Wheels, Pulleys etc. Ultrasonic test on forgings shall be carried out as per norms given below. UT shall be carried out in Proof machined condition (single diameter/ Flat surface without steps, keyways, teeth cutting or other profile machining which can create difficulty in ultrasonic testing). Components shall be identified with Heat number and serial number by punching). Hardening operation shall be carried out prior to Ultrasonic testing.

Unacceptable defects in forgings are as given below:

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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

v. Gear boxes shall be checked at No load for backlash, tooth contact, noise, temperature rise and vibration as per attached Procedure No. PEM (Q)/001.

vi. Test certificates shall be furnished for verification of Type tests including environmental tests - for electrical and electro-mechanical items. If Type tests for items with similar / identical construction are not available, arrangement shall be made to conduct the same in the presence of BHEL/ Customer's representative (as required).

vii. Acceptance and routine tests (HV and insulation) for all electrical and electro-mechanical components and system as per governing specification

FINAL INSPECTION OF CRANES- (TESTING OF CRANES AT SUPPLIER'S 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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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	1.1.1 The gear boxes shall be run under no-load condition at the rated speed for minimum four hours in each direction and the following are to be checked: i. All bolts at the joints remain tight

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	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	1.1.2	General
6.1.0	1.1.3	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.
	1.1.4	Name plate should provide information eg. Ratio, KW rating, Bearing details and manufacturers name.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

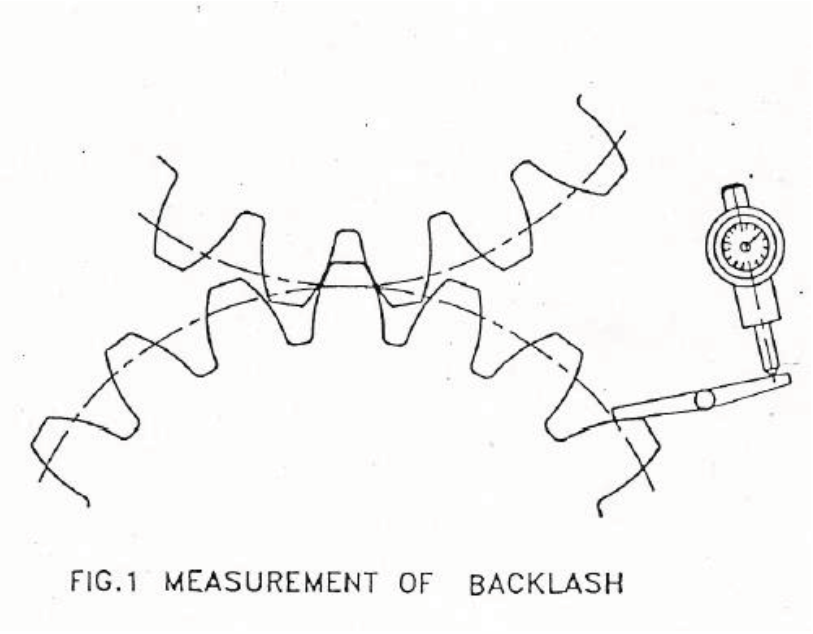


FIG.1 MEASUREMENT OF BACKLASH

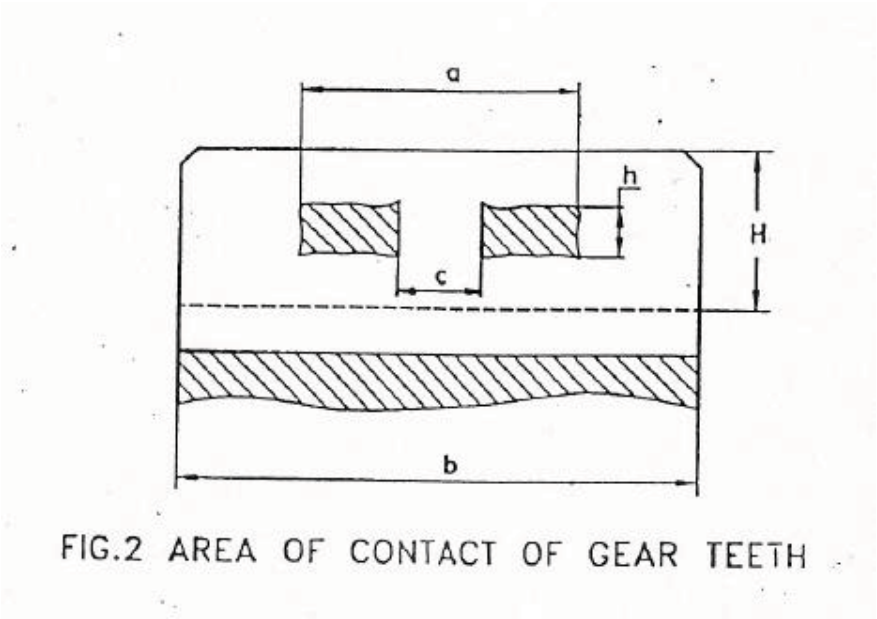


FIG.2 AREA OF CONTACT OF GEAR TEETH

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

TABLE 1

BACKLASH AND 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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL		MANUFACTURING QUALITY ASSURANCE PLAN				CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)						
	ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA		SUB-ITEM	QAP NO.:		REV. NO.	ISSUE DATE :	SUB CONTRACTOR NAME & ADDRESS:					
Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
1	Fabricated Components												
a.	Steels Plates (Box Girder , End Carriage , Crab Frame , Load Frame / Cradle , Fab.Rope Drum & Gear Box Casings)	1. Chemical , Physical & Heat treatment (as applicable)	Major	Corelation with T.C / Check test in absence of T.C	1 / Heat / Batch	---	E250 Grade BR IS: 2062 / APPROVED Drg. / Doc.	E250 Grade BR IS: 2062 / APPROVED Drg. / Doc.	Mfr's T.C / Check Report	P	V	V	Refer Note : 1
		2. NDT	Major	UT	100%	---	ASTM A 578 Level B	ASTM A 578 Level B	UT Report	P	V	V	UT on 12.5 mm & above thickness plates.
		3. Material Identification , Trasfer Stamping & dimensional thickness check.	Major	Visual Check , Measurement	100%	---	Check Report	Check Report	Check Report / Log Book	P	V	V	
b.	weld setup	dimension	Major	Measurement	100%	---	Component Drawing	Component Drawing	Inspection Report	P			
1A	Seamless Pipe for Rope Drum	1. Chemical & Physical	Major	Corelation with T.C / Check test in absence of T.C	100%	---	ASTM-A 106 GR-B	ASTM-A 106 GR-B	Mfr's T.C / Check Test Report	P	V	V	Refer Note : 1
		2. NDT	Major	Micro Etching / Flattening for seamless pipe	100%	---	ASTM-A 106 GR-B	ASTM-A 106 GR-B	MTC / Lab TC	P	V	V	
		3. NDT	Major	UT	100%	---	ASTM 578 Level B	ASTM 578 Level B	UT Report	P	V	V	
2	Welding WPS (Welding procedure specification) in line eith ASME Sec. IX (QW - 482) - For Box Girders , Endcarriage , Crab Frame , Rope Drum & Load Frame / Cradle & Gear Box Casing.												
a.	WPS . PQR & WPQ	Welding Parameters	Major	Review of Documents	100%	---	ASME Sex. IX	ASME Sex. IX	QW-482 , QW-483 , QW-484 as per ASME Sec IX	P	V	V	WPS/PQR/WPQ approved by NTPC/BHEL & other reputed PSUs shall be submit for review. (Log Book to be maintained during fabriacation)
b.	Root Run / Back chipping	NDT	Major	DPT	100%	---	ASME Sex. - VIII, Div-I , Appn - 8	ASME Sex. - VIII, Div-I , Appn - 8	Welder log book / DP Report	P	V	V	
c.	Butt weld	NDT	Critical	RT	100% in tension, 25% in compression, 100% in Rope drum	100% in tension, 25% in compression, 100% in Rope drum	ASME Sex. V	ASME Sex. - VIII, Cl UW-51 & 52	RT Report	P	V	V	RT Film shall be Reviewed by BHEL / SJVN.
			Critical	UT	100% UT for non RT area 10% UT in RT area	100% UT for non RT area 10% UT in RT area	ASTM Section V , asme Sec VIII Division I and Appendixe 12.	ASTM Section V , asme Sec VIII Division I and Appendixe 12.	UT Report	P	W	W / V	UT shall be Witnessed by "C" & "S" during final inspection of crane.
			Critical	DPT	100%	10%	ASME Sex. - V & VIII,	ASME Sex. - VIII, Div-I , Appn - 8	Inspection Report	P	W	W / V	DP Test of Butt welds for rope drum to be conducted after final machining. 10% random witness.
d.	Fillet weld	Size and surface defects	Major	Visual Check	100%	---	Manufacturing Drawing	Manufacturing Drawing	Inspection Report	P	V	V	

	PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY PLAN			CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)								
	ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA	SUB-ITEM	QAP NO.: 437-501-A501 PE-V0	REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:							

Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
		NDT	Major	DPT	100%	10%	ASME Sex. V	ASME Sex. - VIII, Div-I, Appn - 8	Inspection Report	P	W	W / V	1. NDT of weld joints before closng of box girder 10% random witnessed by BHEL / SJVN at the time of final inspection. 2. DP Test of fillet welds for rope drum to be conducted after final machining 10% random witnessed by BHEL / SJVN
	NDT & dimensions of weld joints in Box Girder(before closing)	NDT & dimensions	Major	DPT/MPI	100%	10%	ASME Sex. V	ASME Sex. - VIII, Div-I, Appn - 8	Inspection Report	P	W	W	
				dimensions	100%	100%	drawings	drawings					
e.	**Inspection of fabricated components.**	1 .Visual examination , Dimension for Girder, End carriage , Crab Frame , Hand Ralling , Rope drum etc. Camber , Verticality, bend , Surface finish & Material tracibility etc.	Major	Visual check & Dimensional Measurement	100%	---	TS / DRG. / IS3177 / IS 807	TS / DRG. / Relevant Standard	Inspection Report	P	V	V	
f.	**Heat Treatment of Rope Drum (if fabricated)**	Stress Relieving	Major	Review SR Chart	100%	---	Approved Drawing / Relevant standard / ASME Section V , ASME Section VIII , Division-I , UCS-36	Approved Drawing / Relevant standard / ASME Section V , ASME Section VIII , Division-I , UCS-36	SR Chart	P	V	V	
3	**Gear Box Casing**												
a.	**Material**	Surface Condition	Major	Visual Check	100%	---	Manufacturing Drawing	Manufacturing Drawing	Inspection Report	P	V	V	
		Chemical & Physical	Major	Corelation with T.C / Check test in absence of T.C	100%	---	Manufacturing Drawing / IS:2062	Manufacturing Drawing / IS:2062	Mfr's T.C & Inspection Report	P	V	V	
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	**PLATFORM**	Dimensional conformity	Minor	Measurement	100%	---	Manufacturing Drawing	Manufacturing Drawing	Vendor Inspection Report	P	V	V	
5	**L.T FRAMES & HAND RAILING.**	Dimensional conformity	Minor	Measurement	100%	---	Manufacturing Drawing	Manufacturing Drawing	Vendor Inspection Report	P	V	V	
6	**CABIN**	Dimensional conformity	Minor	Measurement	100%	---	Manufacturing Drawing	Manufacturing Drawing	Vendor Inspection Report	P	V	V	
7	**Current collector arms**	Verification of make , Type , Rating and Dimensional conformity	Minor	Measurement	100%	---	Manufacturing catalogue	Manufacturing catalogue	Vendor Inspection Report	P	V	V	
8	**DSL GUARD**	Verification of make , Type , Rating and Dimensional conformity	Minor	Measurement	100%	---	TS / DRG. / IS 2062	TS / DRG. / IS 2062	Vendor Inspection Report	P	V	V	

	PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY ASSURANCE PLAN			CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)			
एसजेवीएन SJVN	ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA	SUB-ITEM	QAP NO.: 437-501-A501 PE-V0	REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:		

Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
9	Rails	Dimensional conformity	Major	Measurement	100%	100%	GA Drawing / IS:3443 / Vendor TC / Appd.Data Sheet	GA Drawing / IS:3443 / Vendor TC / Appd.Data Sheet	Vendor Inspection Report	P	V	V	
		Chemical , Mechanical & Hardness	Major	Chemical , Mechanical & Hardness	100%	100%	IS:3443 - 1980	IS:3443 - 1980	Mfr's T.C	P	V	V	
10	MECHANICAL COMPONENTS												
A	Wheels												
	i) Raw Material	1. Chemical composition & Mechanical properties.	Major	Corelation with Mfr's T.C	100%	100%	Manufacturer Drg . / IS 1570 / BS-970	Manufacturer Drg . / IS 1570 / BS-970	Test Certificate	P	V	V	Refer Note :1
		2. Heat Treatment	Major	Review MTC	100%	100%	Approved Drawing / Relevant standard	Approved Drawing / Relevant standard	MTC	P	V	V	
	ii) Machined	a) Dimensions	Major	Measurement	100%	100%	Manufacturing Drawing	Manufacturing Drawing	Inspection Report	P	V	V	
		b) Hardness		Mechanical	100%	100%	Approved Data Sheet / Mfg. Drg.	Approved Data Sheet / Mfg. Drg.	Inspection Report	P	V	V	
		c) UT		NDT	100%	100%	ASTM A 388	ASTM A 388 & Annexure V	UT Report	P	V	V	
		d) DPT		NDT	100%	100%	ASME Sex. - VIII, Div-I, Appn - 8	ASME Sex. - VIII, Div-I, Appn - 8	Inspection Report	P	V	V	
	b) Raw material for Gears , Pinions , Shaft , Axels , Coupling Shaft etc.	i) Chemical composition & heat treatment, Physical Properties.	Major	Corelation with T.C / Check test in absence of T.C	100%	100%	Manufacturer Drg . / BS : 970 / IS 1570 / Approved data sheet	Manufacturer Drg . / BS : 970 / IS 1570 / Approved data sheet	Mfr's T.C / Check Test Report	P	V	V	
		ii) UT (after machining)	Major	UT	100%	100%	ASTM A 388	ASTM A 388 & Annexure V	UT Report	P	V	V	
		iii) Hard ness	Major	Check for Hardness	100%	100%	Approved Data Sheet / Mfg. Drg./ IS 3177	Approved Data Sheet / Mfg. Drg./ IS 3177	Inspection Report	P	V	V	
		iv) Dimensions	Major	Measurement	100%	100%	Manufacturing Drawing	Manufacturing Drawing	Inspection Report	P	V	V	
		v) D.P Test on Teeth , Bore & Tooth OD	Major	NDT	100%	100%	ASTME - 165	No Linear indication	Inspection Report	P	V	V	
	c) Casting for Gears and pinions, if applicable	i) Chemical & Physical	Major	Chemical & Physical	100%	100%	Approved Drg . / Data sheet	Approved Drg . / Data sheet	Mfr's T.C	P	V	V	
		ii) NDT	Major	UT	100%	100%	ASTM A 609	ASTM A 609	UT Report	P	V	V	
		iii) Dimensions	Major	Measurement	100%	100%	Manufacturing Drawing	Manufacturing Drawing	Inspection Report	P	V	V	
B	Pulley, Brake drum, coupling & other Major steel casting & forging												
	i) Material	Chemical / Physical	Major	Corelation with Mfr's T.C	100%	100%	Manufacturer Drg .	Manufacturer Drg .	Mfr's T.C	P	V	V	

	PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY ASSURANCE PLAN				CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)						
	ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA	SUB-ITEM	QAP NO.: 437-501-A501 PE-V0		REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:					

Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
	ii) Machined	a) Dimensions	Major	Measurement	100%	100%	Components Drawing	Components Drawing	Inspection Report	P	V	V	
		b) DPT after machining	Major	NDT	100%	100%	ASTM E - 165	ASTM E - 165	Inspection Report	P	V	V	
		c) Hardness	Major	Check for Hardness	100%	100%	Approved Data Sheet / Mfg. Drg.	Approved Data Sheet / Mfg. Drg.	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 & Measurement	100%	100%	Vendor Standard	Smooth Running no oil leakage , Noise 85 db at 1 Mtr. Max. Temp. rise 30° C above amb temp.	Inspection Report	P	V	V	
D	a) Top block , Bottom block	Dimensional conformity	Major	Measurement	100%	100%	Assembly Drawing.	Assembly Drawing.	Vendor Inspection Report	P	V	V	
	b) Hook	i) Chemical Composition , Heat treatment , Mechanical properties on integral test bar.	Major	Chemical , Heat treatment & Tensile , % Elongation.	100%	100%	IS : 1875		Test Certificate , HT Chart & Inspection report	P	V	V	
		ii) UT on raw material of Hook	Major	UT	100%	100%	ASTM A 388	UT Procedure & Annexure V		P	V	V	
		iii) Forging operation of hook	Major	Visual	100%	100%	IS:5749 / IS:15560	IS:5749 / IS:15560		P	V	V	
		iv) Proof Load Test	Major	Mechanical	100%	100%	IS:5749 / IS:15560	IS:5749 / IS:15560		P	W	W	
		v) UT & MPI after proof load test.	Major	UT & MPI	100%	100%	ASME Sec. V / SE 709	UT Procedure & Annexure V		P	W	W	
		vi) identification Punch (By BHEL or Customer, after proof load & NDT Witness.	Major	Visual	100%	100%	-------	-----	------	P	W	W	CHP - Customer Hold Point.
E	Rope Drum Assembly	i) Dimension	Major	Measurement	100%	100%	Mfg. Drawing	Mfg. Drawing	Inspection Report	P	V	V	
		b) DPT After Machining	Major	NDT	100%	100%	ASTM E - 165	No crack & Linear indication	Inspection Report	P	V	V	

	PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY ASSURANCE PLAN			CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)								
	ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA		SUB-ITEM	QAP NO.: 437-501-A501 PE-V0	REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:						
Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
11	Electrical Components												
a)	Motors (=< 50KW)	a) Make , Rating , Routine Test , IP class	Major	Review Mfr's TC	100%	---	TS / DRG. / IS : 325	TS / DRG. / IS : 325	Mfr's T.C	P	V	V	Refer Note 3 for Motor above 50kW separate QA shall be followed.
		b) Type test	Major	Review Mfr's TC	100%	---	TS / DRG. / IS : 325	TS / DRG. / IS : 325	Mfr's T.C	P	V	V	
b)	Brakes	Make , Type , Rating , Dia , Functional test / Routine test	Major	Review Mfr's TC	100%	---	TS / DRG. / Relevant Standard	TS / DRG. / Relevant Standard	Mfr's T.C	P	V	V	
c)	Control Panel	Interlocking functional , IR , HV , Sheet thikness , cable laying , dressing , ferulling Overall , Dimensions , painting shade , Panel surface finish , Paint thikness , adhesive test , Component fixing , Degree of Protection by paper inserting method.	CR	Test for HV , IR , Functional Check	100%	---	IS : 3177 / Approved Panel Drg. & BOM / Data sheet	IS : 3177 / Approved Panel Drg. & BOM / Data sheet	Inspection Report	P	W	V	Refer Note No.4 VVVFD Test Certificate to be submitted from Approved Vendor for verification.
d)	Radio Remote , Master Controller and Pendant Controller.	HV , IR , Functional	Major	H.V & I.R and IP Class	100%	---	BOM / Mfr. Catalogue	BOM / Mfr. Catalogue	TC	P	V	V	Refer Note No.4
e)	Limit Switches	HV , IR , Functional	Major	H.V & I.R and IP Class	100%	---	BOM / Mfr. Catalogue	BOM / Mfr. Catalogue	TC	P	V	V	
f)	Trailing Cable , Power Control Cable & DSL	Make , Type , Rating , Routine , Acceptance test insulation resistance values	Major	Verification	100%	---	TS / DRG. / Relevant Standard	TS / DRG. / Relevant Standard	TC	P	V	V	
g)	Tranformer	Make , Rating , Routine test	Major	Visual	100%	---	Approved Drg..	Approved Drg..	TC	P	V	V	
h)	SFU , MCCB , MCB , Contactors , DSL , Relays , Fuses	Make , Type , Rating size , Functional , Continuity check	Major	Visual	100%	---	Approved Drg..	Approved Drg..	TC	P	V	V	
i)	Resistance box (DBR)	Make , Type , Rating size , Functional , Continuity check , HV & IR , Temperature rise	Major	Visual	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	TC	P	V	V	
j)	VVVF Drives	Make , Type , Rating , Routine test.	Major	Visual	100%	---	Approved Drg..	Approved Drg..	TC	P	V	V	
k)	Anti collision devices , Cable gland , Lugs , Rectifier , indicating lamps , terminal blocks load cell.	Make , Type , Rating	Major	Visual	100%	---	Approved Drg..	Approved Drg..	TC / IR	P	V	V	
12	Bought Out Items												

PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY ASSURANCE PLAN			CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)								
ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA			SUB-ITEM	QAP NO.: 437-501-A501 PE-V0		REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:				
Sl.No.	**Components & operations**	**Characteristics**	**Class**	**Type of check**	**Quantum of Check**		**Reference Document**	**Acceptance Norms**	**Format of Record**	**Inspection Agency**			**Remark**
					M/C	**S**				**M**	**C**	**S**	
1	2	3	4	5	6		7	8	9	** 10			11
a)	**Wire Rope & Slings**	Identification & Grade	Major	Visual	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Mfr's T.C	P	V	V	
		Dimensional Check	Major	Measurement	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Inspection Report	P	V	V	
		Check for Twist, Kinks, proper thimble end connection & splicing	Major	Visual	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Mfr's T.C	P	V	V	
		Breaking Strength	Major	Review Mfr's TC	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Mfr's T.C	P	V	V	
b)	**Socket / Clamps for Wire Rope**	Tensile test	Major	1 sample	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Inspection Report / TC	P	V	V	Rope shall fail first than the socket or joints.
c)	**Sole Plate & Clamps**	a) Chemical / Physical	Major	Corelation with Mfr's T.C	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Inspection Report	P	V	V	
		b) Dimensions	Major	Measurement	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Inspection Report	P	V	V	
		c) DPT	Major	NDT	100%	---	ASTM E - 165	No Linear indication	Inspection Report	P	V	V	
d)	**Bearing**	Make & Type	Major	Verification	100%	---	TS / DRG. / Relevant Standartd	TS / DRG. / Relevant Standartd	Inspection Report	P	V	V	
e)	**Spares (Mandatory / recommended spare / commisioning spares)**	Type , Rating / Size	Major	Review of Internal Inspection Reports / Mfr's TC / COC	100%	---	Approved spare list	Approved spare list	Inspection Report / COC	P	V	V	Refer Note 6
13	**Assembly of Cranes**												
a)	**Bridge with LT**	Dimension , Wheel level alignment , camber , verticality , bend	Major	Measurement	100%	---	GA Drg. / IS : 3177	GA Drg. / IS : 3177	Inspection Report	P	W	V	
b)	**Crab Assembly**	Dimension , Wheel level alignment	Major	Measurement / Visual	100%	---	GA Drg. / IS : 3177	GA Drg. / IS : 3177	Inspection Report	P	W	V	
c)	**Final Inspection (At Works) with actual panel and pendent**	Overall inspection of crane , Dimensions , Ratings , Hook reaches, Clearance, Span, Diagonal dimensions , Skewness , Wheel base & Gauge , Overhang , LT Buffer , headroom , Cambering of Girder , Visual & Dimensional Check of Load frame / Cradle , Visual & Dimensional Check of slings , Electrical Panel , Insulation Test on Electrical component of Crane , Equipment Layout on Bridge Platform , Elevations / Levels etc.	Major	Measurement	100%	100%	Approved GA Drg. / IS : 3177	Approved GA Drg. / IS : 3177	Inspection Report	P	W	W	

	PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY ASSURANCE PLAN				CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)					
	ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA	SUB-ITEM	QAP NO.: 437-501-A501 PE-V0	REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:					

Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
		No Load & Load Tests											
		a) No Load : Hoists , CT & Current Measurement , No Load Running of LT Machinery for Direction and Speed with VVVFD , Check of working range , Testing of fault panel function , Test of emergency stop at no load , functional check	Major	Measurement	100%	100%	Approve Drgs.	Approve Drgs.	Inspection Report	P	W	W	
		b) SWL : Hoists , CT Speed , Current & Deflection Measurement , Simultaneous operation of main and auxiliary hoists , Functional check of emergency stop , Overload Protection , Visual inspection & DPT of accessible weld joints after load test, Measurement of throat opening of hook after load test , witness for variable frequency drive., DP test of hook after load test	Major	Operational check & Measurement	100%	100%	Approved GA Drg. / IS : 3177	Approved GA Drg. / IS : 3177	Inspection Report	P	W	W	
		c) Overload: Hoisting only (at 125% of SWL)	Major	Only watching motions	100%	100%	Approved GA Drg. / IS : 3177	Approved GA Drg. / IS : 3177	Inspection Report	P	W	W	
		d) Operation check of brakes and Limit Switches	Major	Operational check	100%	100%	Approved GA Drg. / IS : 3177	Approved GA Drg. / IS : 3177	Inspection Report	P	W	W	
14	**Inspection of Electric Hoist**	Measurement of Speed , load test , Operation of all protective Device , Overload test (@125% of SWL) , Holding capacity of brakes .	Major	Operational check & Measurement	100%	100%	Approved Drg. / IS : 3938	Approved Drg. / IS : 3938	Inspection Report	P	W	W	Load and Over Load test shall be done by shop testing beam & stand.
15	**Painting**	Surface preparetion , Painting DFT & Adhesion test	Major	Visual	100%	---	Approved Drg. / Document	Approved Drg. / Document	Inspection Report	P	V	V	
16	**Packing**	Visual	Major	Visual	100%	---	Manufacturer Standard	Manufacturer Standard	Packing List	P	V	V	

PROJECT NAME (MW) : 4x225 MW ARUN III HEP NEPAL	MANUFACTURING QUALITY ASSURANCE PLAN					CONTRACTOR NAME & ADDRESS : Bharat Heavy Electricals Limited. Project Engineering Management,PPEI Building, HRDI and ESI complex, Plot no. 25, Sector -16 A,Noida-201 301 (U.P.)						
ITEM DESCRIPTION :100/20T DG EOT CRANE FOR TRANSFORMER CAVERN AREA		SUB-ITEM	QAP NO.: PE-V0 437-501-A501		REV. NO. 2	ISSUE DATE : 06/07/2019	SUB CONTRACTOR NAME & ADDRESS:					
Sl.No.	Components & operations	Characteristics	Class	Type of check	Quantum of Check		Reference Document	Acceptance Norms	Format of Record	Inspection Agency			Remark
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	** 10			11
Note 1 :	Original TCs / Photocopies certified in original by mill / dealer shall be furnished for review. check test in absence of co-related TCs Check test shall be carried out from one piece per heat / per batch 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 Thikness upto 19 mm and Gamma Ray for Thikness above 19 mm. If Gamma Ray is used for lower thickness slow speed film like D2 or equvalent which was given enough readable and interpretable film quality to be used for clarity. All NDT shall be carried out by Qualified level II personel.												
Note 3 :	Less than 20KW : Acceptance of motor less than 20KW is based on COC of the manufacturer & the contractor confirming as follow: It is hereby confirmed that the above mentioned motor / motors was / were manufactured taking care of customer specific requirement regarding ambient temp. , voltage & frequency variation , hot starts , pull out torque , starting KVA / KW , temp. rise , distance between center of stud & gland plate and tested in accordance with approved drawing / data sheets.												
	20 KW to 50 KW : Acceptance of motor rating between 20 KW & 50 KW is based on customer review of routine test inspection report as per IS 325 along with COC the manufacturer & the contractor confirming as follow: It is hereby confirmed that the above mentioned motor / motors was / were manufactured taking care of customer specific requirement regarding ambient temp. , voltage & frequency variation , hot starts , pull out torque , starting KVA / KW , temp. rise , distance between center of stud & gland plate 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.												
Note 6 :	Quality Plans as approved for main equipment shall be applicable for the type of control measure i.e make test / checks etc. for the procurement / manufacture of mandatory spares. However , for those spares which are not covered in the approved Quality Plan, Manufacturer shall furnish Certificate of Conformance (COC) along with Guarantee and Interchange ability certificate.												
Note 7 :	De energized & Energized test shall be conducted as per attached Annexure III.												
Note 8:	Annexue V: Acceptance criteria for UT (as per ASTM A 388) of Gear, pinion, LT & CT wheels , Axle shafts, Hooks & Nuts												

LEGENDS

M : MANUFACTURER	C : CONTRACTOR	S : SJVN LTD.
P : PERFORM	V : VERIFICATION	W : WITNESS / CHP
IR : INSPECTION REPORT	DRG : DRAWING	CHP : CUSTOMER HOLD POINT
MA : MAJOR	MN : MINOR	CR : CRITICAL
ME : MEASUREMENT	NDT : NON DESTRUCTIVE TESTING	HT : HEAT TREATMENT
TR1 : CERTIFICATE OF COMPLIANCE TO TS / STANDARD REQUIREMENT WITHOUT ANY CHECK LIST OF TESTS CARRIED OUT.	TR2 : CERTIFICATE OF COMPLIANCE TO TS / STANDARD REQUIREMENT WITH CHECK LIST OF TESTS CARRIED OUT.	TR2 : CERTIFICATE OF COMPLIANCE TO TS / STANDARD REQUIREMENT WITH CHECK LIST OF TESTS CARRIED OUT.

MANUFACTURER / SUB-CONTRACTOR :		CONTRACTOR :	FOR SJVN USE :	REFERENCE DOC. NO. OF SJVN	
PREPARED BY :	REVIEWED BY :	REVIEWED & RECOMMENDED BY	REVIEWED BY	RECOMMENDED BY	APPROVED BY
NAME , DESIGNATION & SIGNATURE		NAME , DESIGNATION & SIGNATURE	NAME & SIGNATURE	NAME & SIGNATURE	SIGNATURE & SEAL

ANNEXURE- II

PROCEDURE FOR LOAD TEST & OVERLOAD TEST
ARUN-3 HYDRO ELECTRIC PROJECT (NEPAL) (4X225MW)

Following procedure to be followed for load & Overload test as per IS 3177. (At work)

Load test:

After the no load running test has been completed , the crane should be tested with loads in the followin manner.

a) Raise a load equal about 50 percent of the rated load not higher than required to clear its support & stop adjust the brake , if nacessary . Raise a SWL **150T** Load upto 5 Minuts about 1000 mm above its support & stop. Lower the load about 300 mm & stop. Check drift of load during stopping.

If load drift, brakes are not in proper adjustment and should be corrected. Repeat this operation until proper adjustment of brake is obtained. Lower load carefully back to its support.

b) Load the hoist motion with 100% of rated capacity and follow the same procedure as mentioned in (a).

i. Mark the span center of crane & also mark wheel base of the trolley.

ii. Keep the trolley at the span center & check reading for deflection. (No load deflection).

iii. Hoist the load high enough to clear all obstructions but not higher than necessary & move trolley across entire span and check deflection reading with trolley at middle and extreme end of bridge

iv. Measure full load current for hoist motor.

v. Lower the hoist remove all the load & measure deflection reading again which should match with no load deflection reading & ensure that no permanent set.

vi. Lift the 250T SWL & move the trolley for a distance of 500 mm in both directions.

vii. Measure full load current for cross travel motor.

viii. Preparation for load test shop wire rope & shop testing cable to be used.

Over load test: (As per IS 3177)

Load the hoist motion with 125% of rated capacity , lift the load for 1000 mm height and then lower the load.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE III: DE-ENERGISED & ENERGIZED TESTS

S. No.	Type of Test	Activity	Result (Accepted / Not Accepted
1	**DE-ENERGISED TESTS**		
a	Steel Structure	Visual check	
b	Bolts and Nuts	Visual check *	
c	Securing devices for all wire ropes.	Visual check *	
d	Crane Cabin-Platform.	Visual check *	
e	Gangway.	Visual check *	
f	Surface/Painting.	As per Clause 15 of MQP	
g	Boggies - Traveling Wheels.	Visual check	
h	All Main Hooks W / Housing and Safely Latch	Visual check	
i	All aux Hooks W/Housing and Safety Latch.	Visual check	
j	Bolts for all motors.	Visual check	
k	Inspection of spare parts.	As per Clause 12 (e) of MQP	
l	Insulation tests of various drive motors	Perform	
m	Air gap of brakes measurement.	Perform **	
n	Examine wire ropes.	Visual check	
o	Inspect clean and oil all moving mechanical parts.	Visual check	
p	Check oil level in hoists and traveling motors gearboxes and 'top-up'.	Visual check *	
q	Check and grease rope guide and drums.	Visual check *	
r	Check and examine cable trolley, track system, moving and connection parts.	Visual check *	
s	Check bus-bar suspension bolts, brackets and current collectors.	Visual check *	
t	Check and examine all electrical control panel cables, connection terminals.	Visual check	
u	Check and examine all contactor and thermal protection device	Visual check	
v	Check cable glands and insulation of cables.	Visual check *	
w	Setting on the control card (APC, exi. I/O comm.). if applicable	Visual check & Perform *	
x	Clean up dust and oil.	Visual check	
2	**ENERGIZED TESTS**		
a	Testing of the APC and exi. i/O boards, if applicable.	*	
b	Testing of the digital inputs/outputs, if applicable	At shop	
c	Testing of the analogue in puts, if applicable.	At shop	
d	Testing or the control panel function.	As per Clause 11 (c) of MQP	
e	Testing of the lights.	*	
f	Testing of the anti-condensation heaters.	*	
g	Testing of the phase order of the 415 V AC.	At shop	

* Partial numbers of nut & bolts shall be install during testing at works further ~~cabin~~, platform , gangway , lights , actual wire rope , ~~panels~~ , cables , glands , etc. shall not be install with the crane during testing at the crane at works , however visual check can be performed.

** Proper brake setting shall be done as per requirement.

Annexure-V

Acceptance Criteria for UT (As per ASTM A 388) of Gear, Pinion, LT& CT Wheels, Axle, Shafts, Hooks and Nuts

Following defects are not acceptable: -

1) Cracks, flakes, seams and laps.
2) Defect giving indication larger than 4 mm equivalent reflector size
3) Group of defect with maximum indication less than that from a 4mm diameter equivalent flaw which cannot be separated at testing sensitivity, if back echo is reduced to less than 40%.
4) Defects giving indication of 2-4 mm diameter equivalent flaw separated by a distance less than four time the size of the larger of the adjacent flaws.

Note:- a) For hooks, DGS method of Ultrasonic Testing shall be used.

b) For shafts & axles, scanning to be done in axial as well as transverse direction.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SUB-SECTION IA

CUSTOMER SPECIFICATION

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION-23

EOT CRANES

23.1 SCOPE OF WORK

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, unloading, site storage and preservation, in plant transportation at site, erection / installation, testing supervision, pre commissioning, successful commissioning, performance and acceptance testing, training of Employer's personnel, handing over and warrantee for two years of EOT Cranes, as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation. The scope of work covered under this section shall be read in conjunction with General Technical specifications, Chapter-1.

23.1.1 Detailed Scope of Work

The intent of scope of work shall be a comprehensive functional system complete in every respect including but not be limited to following:

A) 250/50/10 T EOT cranes for Power House

i) Two (2) nos., 250/50 - tonnes Power House Electric Over Head Travelling bridge cranes of approximately 20 m (tentative) span, each crane complete with electric control panels, operator's cabin, remote radio controls, main and auxiliary hoists on a common trolley, brakes, safety devices, platform, ladders, fittings and connections and all necessary accessories and load cells.

ii) Two (2) nos., 10 -tonnes power house monorail cranes supported on the side of the bridge girders of EOT crane on unit # 1 and Unit # 4 side complete with electric controls, hoists, brakes, safety devices, fittings and connections and all necessary accessories,

iii) One (1) equaliser beam, fittings, connections, electric controls and other accessories required when the cranes are operating in tandem for lifting rotor,

iv) One (1) set of fabricated steel equaliser beam stand(s) for support when beam is not in use.

B) 150/30 T EOT cranes for PGV / BFV House

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

One (1) No. 150/30T capacity EOT crane for PPV House suitable to operate as and when required complete with all accessories and slings. Electric over head travelling bridge crane of span approximately 10m. (tentative), complete with electric control panels, remote radio controls hoist on trolley, brakes, safety devices, platform, ladders, fittings and connections and all necessary accessories. Actual span and length will be finalized during detailed engineering stage.

C) 100/20 T EOT cranes for Transformer Cavern

One (1) No. 100/20T capacity EOT crane for Transformer Cavern suitable to operate as and when required complete with all accessories and slings. Electric over head travelling bridge crane of span approximately 14 m (tentative), complete with electric control panels, remote radio controls, hoist on trolley, brakes, safety devices, platform, ladders, fittings and connections and all necessary accessories. Actual span and length will be finalized during detailed engineering stage.

D) 10 T EOT cranes for GIS Building

One (1) No. 10T capacity EOT crane for GIS Building suitable to operate as and when required complete with all accessories and slings. Electric over head travelling bridge crane of span approximately 16 m (tentative), complete with electric control panels, remote radio controls, hoist on trolley, brakes, safety devices, platform, ladders, fittings and connections and all necessary accessories. Actual span and length will be finalized during detailed engineering stage.

E) 50/10T EOT crane for Workshop crane

One (1) No. 50/10T capacity EOT crane for Workshop Building suitable to operate as and when required complete with all accessories and slings. Electric overhead travelling bridge crane of span approximately 10 m (tentative), complete with electric control panels, remote radio controls, hoist on trolley, brakes, safety devices, platform, ladders, fittings and connections and all necessary accessories. Actual span and length will be finalized during detailed engineering stage.

F) Miscellaneous items

i) One (1) set of main runway rails with base plates, anchor bolts, rail clips, lock nut, end stops, limit switches, striker's plates, buffers etc. for each of the cranes,

ii) Two (2) sets of bridge rails with rail clips, lock nut, end stops, limit switches, striker's plates, buffers etc. mounted on each of the crane girders,

iii) Two (2) sets of Nylon slings suitable for lifting stator assembly, ~~2 sets of Nylon slings for BFV / MIV and 2 sets of Nylon Slings for runner etc.~~){Approximate single side length of 20 m each}

iv) ~~One(1) set of cradles (common for power house, transformer hall and PPV)~~

v) ~~One(1) set of cradles (common for GIS and Workshop)~~

vi) One (1) set of down shop lead (DSL) with indication system for power supply system complete with metal enclosures, conductors, collector trolleys, all fittings and connections etc. for total runaway length of the respective cranes as per layout drawings.

Till the installation and commissioning of DSL temporary cable for erection testing commissioning and further operation of crane for installation work shall be arranged by the contractor at each location.

vii) Load testing of cranes at site including load arrangement ~~(arrangement of steel plates~~ or/and casting of concrete blocks etc.) and all logistics,

viii) Lubricating oil, grease and hydraulic brake fluid for first filling of all components with 100% reserve, in non-returnable drums, for each crane.

ix) Suitable rating receptacles along with copper cable between DSL and receptacle for each crane.

F) Control, monitoring and related items and services

Co-ordination and provision of necessary contacts and/or ports for integration with plant SCADA system.

G) Common supplies and services

i) Routine maintenance including supply of consumables, breakdown maintenance of EOT Cranes, supply of DSL as well as rails ~~and provision of qualified operator (24X7~~) shall be in the scope of contractor upto handing over of the cranes.

ii) ~~Obtaining statutory clearance / licensee for radio remote control system.~~

iii) Drawings, documents and design calculations as per clause 23.6.

iv) Shop, assembly, inspection & tests as per clause no. 23.7.

v) Packaging, ~~handling and site storage~~ as per clause no. 23.8.

vi) Delivery, ~~installation and commissioning~~ as per clause no. 23.9.

vii) Tools and instruments as per clause no. 23.10.

viii) Spare parts as per clause no. 23.11

ix) ~~Field/touch-up painting~~ including all painting materials.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

H) Completeness of System

Any other item (s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard (s)/best international practice.

23.2 STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

23.3 PARAMETERS & GUARANTEES

23.3.1 Specific Parameters and Layout Conditions

23.3.1.1 250/50/10 T EOT cranes for Power House

The powerhouse EOT and monorail cranes shall be required for handling turbine components, generator, associated apparatus and other equipment in the powerhouse. The cranes shall be used for the installation of above equipment as well as for the routine maintenance after completion of the powerhouse. The two powerhouse EOT cranes shall be capable of operation in tandem.

In coupled tandem operation, the powerhouse cranes shall be used to lift a complete generator rotor mass including lifting device. The cranes should be designed in such a way that the cabins are located besides each other during tandem operation and controlled by any one of the cabins. The Contractor shall supply necessary control and cables for this purpose.

One monorail crane shall be installed on each power house EOT crane. Monorail crane shall be arranged on a single under-running beam suspended beneath the bridge girder closest to walls of the control block. The crane design shall be coordinated with the turbine, generator and transformer design for capacity and other provisions in the cranes with respect to installation layouts. The Contractor shall supply the required capacity of cranes if requirement is higher than 250 T for

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

main hook. The main hook of the 250 T EOT cranes shall have anti-sway arrangement.

Installation of the equipment shall be done by the Contractor at Site (exact location shall be intimated by Employer at the time of installation). Material/manpower required for such installation shall be arranged by the Contractor.

Technical literature of the equipment/components offered and as published by the original manufacturer of the component, shall be submitted.

23.3.1.2 150/30 T EOT cranes for PGV House

The 150T EOT Crane shall be required for handling Penstock guard valves and associated equipment. The cranes shall be used for installation of the above equipment as well as routine maintenance after completion of power house. The crane design shall be coordinated with the Valve design for capacity and other provisions in the cranes with respect to installation layouts. The contractor shall supply the required capacity of cranes if requirement is higher than 150T for main hook. The main hook of the 150 T EOT cranes shall have anti-sway arrangement.

23.3.1.3 100/20 T EOT cranes for Transformer Cavern

The 100T EOT Crane shall be required for handling Generator Transformers and associated equipment. The cranes shall be used for installation of the above equipment as well as routine maintenance after completion of power house. The crane design shall be coordinated with the Transformer design for capacity and other provisions in the cranes with respect to installation layouts. The contractor shall supply the required capacity of cranes if requirement is higher than 100T for main hook. The main hook of the 100 T EOT cranes shall have anti-sway arrangement

23.3.1.3 10 T EOT cranes for GIS Building

The 10T EOT Crane shall be required for handling GIS and associated equipments in the GIS Building. The cranes shall be used for installation of the above equipment as well as routine maintenance after completion of GIS works. The crane design shall be coordinated with the GIS Layout design for capacity and other provisions in the cranes with respect to installation layouts. The contractor shall supply the required capacity of cranes if requirement is higher than 10T. The hook of the 10 T EOT cranes shall have anti-sway arrangement

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

23.3.1.4 50/10 T EOT cranes for Workshop

The 50/10T EOT Crane shall be required for handling workshop equipments in the Workshop Building. The cranes shall be used for installation of the above equipment as well as routine maintenance after completion of workshop. The crane design shall be coordinated with the Workshop Layout design for capacity and other provisions in the cranes with respect to installation layouts. The contractor shall supply the required capacity of cranes if requirement is higher than 50T. The hook of the 50 T EOT cranes shall have anti-sway arrangement

23.3.2 RATING AND FUNCTIONAL CHARACTERISTICS

Rating and functional characteristics of all the components of the EOT Cranes shall be of latest state of the art. If the system components mentioned in the awarded contract becomes obsolete at the time of approval of General technical particulars during detail engineering, the Contractor shall offer the latest model without any extra cost to purchaser. The components of the system shall be selected taking the following requirements into consideration:

- Reliability of components and subsystems.
- Scalability of the system for future extensions.
- Availability of spares.
- Ease of maintenance.

A) Power House Cranes

The EOT cranes shall be designed for the following parameters/duties:

A.	Capacity (in Tonnes)	
i)	Main	250 T (capacity of one crane)
ii)	Auxiliary	50 T
iii)	Monorail	10 T
B.	Span (s)	20,000 mm (approx.)
C.	Normal speeds with full loads, in m/minute	
a)	Main hoist for loads up to 250T	
i)	Hoisting & lowering speed	0-1.0 m/min
b)	Aux. hoist for loads up to 50 T	
i)	Hoisting & lowering speed	0-5.0 m/min
c)	Trolley Travel	10.0 m/min
d)	Bridge Travel (long travel)	0-25. 0 m/min

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

D	Maximum acceleration / deceleration of bridge travel & trolley travel.	0.2 m/sec^2			
E.	Crane hook vertical travel reach	**Main Hook**		**Aux. Hook**	
i)	Between service bay floor *EL-539.0* m to upper most position	≥ 13,000 mm		≥ 13,200 mm	
ii)	Between service bay floor level to lower most position	≥ 15,000 mm		≥ 17000 mm	
iii)	Total hook travel	≥ 28,000 mm		≥ 30,200 mm	
F.	Position of Hook from Rail C/L (mm)	**Crane No.1**		**Crane No.2**	
		Main Hook	**Aux. Hook**	**Main Hook**	**Aux. Hook**
i)	On Upstream side	2000	3600	2700	1100
ii)	On Down stream side	2700	1100	2000	3600
G.	Position of centerline of Hook from End Walls	**Main Hook (mm)**	**Aux. Hook (mm)**	**Mono rail hook (mm)**	
i)	From service bay Aux. block end wall **Crane No.1**	5150	5150	1400	
ii)	From Unit-4 side Aux block end wall **Crane No.2**	5150	5150	1400	
H.	Runway level and Travel lengths				
i)	Crane beam top level	EL. 552.0 m			
ii)	Length of run way	≥ 159,000 mm			
iii)	Trolley travel length	Max. Feasible for specified crane span and hook reaches.			
I.	Distance from rail C/L to nearest side obstruction on				
i)	Up-stream	1250 mm			
ii)	Down-stream	1250 mm			
J.	Distance from crane end to nearest side obstruction				
i)	Up-stream	500 mm			
ii)	Down-stream	500 mm			
K.	Monorail Hoist {Attached under Crane Girder (one per crane)}				
i)	Capacity	10 tonnes			
ii)	Hoist speed with full load	12 m/min			
iii)	Cross Travel speed with full load (along the bridge)	12 m/min.			

iv)	Vertical Lift of monorail hook	
a)	Between service bay floor *EL-539.0* m to upper most position	10500 mm
b)	Between service bay floor level to lower most position	25,000 mm
v)	Position of Hook from rail centre line	
a)	Upstream side	1800 mm
b)	Downstream side	1800 mm
L	Means for Micro speed for Inching Motion for lifting hooks.	Step less, frequency converter speed control system
M.	Factors of safety & Deflections:	
a)	Minimum Factors of safety for Design	
i)	For structural members based on ultimate tensile strength	As per IS 807(Latest)
ii)	For ropes & slings, based on ultimate tensile strength	As per IS 807(Latest)
b)	Deflection limit of girder under safe working load plus dead loads.	1/750th (IS 807-2006 ***Clause 20*** page 42) of span with weight of crab in central position

B) Transformer Hall Cavern

The EOT crane shall be designed for the following parameters/duties:meters:

A.	Capacity (in Tonnes)	100/20 T
B.	Span (s)	Refer crane clearance diagram
C.	Normal speeds & with full loads	
i)	Hoisting speed for hook hoist	1.0 m/min (Main), 5.0 m/min (for Aux)
ii)	Trolley Travel (Cross)	10.0 m/min
iii)	Bridge Travel (long travel)	25.0 m/min
D	Max. acceleration / deceleration of bridge travel & trolley travel.	0.2 m/sec^2
E.	Crane hook vertical travel reach on transformer floor	Refer crane clearance diagram
F.	Required hook approach limit from Rail centre line	
i)	On Upstream	Refer crane clearance diagram
ii)	On Down stream	
G.	Hook reach from the left & right side walls of Hall end stops on side	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	walls	
H.	Runway; Travel lengths	
i)	Crane beam top level	Refer crane clearance diagram
ii)	Length of run way	
iii)	Trolley travel length	Max. Feasible for specified crane span shall ensure hook reaches
I.	Factors of safety & Deflections:	
a)	Minimum Factors of safety for Design	
i)	For structural members based on ultimate tensile strength	The factor of safety and stress level shall be as per IS-807
ii)	For ropes & slings, based on ultimate tensile strength	6
b)	Deflection limit of girder under rated load plus dead loads.	As per IS 807

C) PPV House Crane

The EOT crane shall be designed for the following parameters/duties:meters:

A.	Capacity (in Tonnes)	
i)	Main	150 T
ii)	Auxiliary	30 T
B.	Span (s)	10000 mm (approx.)
C.	Normal speeds with full loads, in m/minute	
a)	Main hoist (200 T)	
i)	Hoisting & lowering speed	0-1.0 m/min
b)	Auxiliary hoist (40 T)	
i)	Hoisting &lowering speed	0-5.0 m/min
c)	Trolley Travel	0-10 m/min
d)	Bridge Travel (long travel)	0-25 m/min
D	Max. acceleration/ deceleration of bridge travel & trolley travel.	0.2 m/sec^2

E.	Crane hook vertical travel reach between PPV cavern floor level (viz service bay floor to upper most position)	**Main Hook** 8000 mm (approx.)	**Aux Hook** 8500mm (approx)
F.	Required hook approach limit from Rail centre line	**Main Hook**	**Aux. Hook**
i)	On Upstream	≤ 2,000 mm	≤ 3000 mm
ii)	On Down stream	≤ 3000 mm	≤2000 mm
G.	Position of Hook from End walls	≤ 3500 mm	≤ 3500 mm
H.	Runway; Travel lengths		
i)	Crane beam top level	EL 785.00 M	
ii)	Length of run way	97000 mm	
iii)	Trolley travel length	Max. Feasible for specified crane span and shall ensure hook reaches.	
I. i)	Distance available between rail centre line and walls on either side (U/s and D/s) from rail C/L to nearest side obstruction on	1,000 mm	
ii)	Min. clearance between extreme point of crane and U/s & D/s side walls.	500 mm	
J.	Means for Micro speed for Inching Motion for main lifting hooks.	Step less, frequency converter speed control system	
K.	Factors of safety & Deflections:		
a)	Minimum Factors of safety for Design		
i)	For structural members based on ultimate tensile strength	As per IS 807(Latest)	
ii)	For ropes & slings, based on ultimate tensile strength	As per IS 807(Latest)	
b)	Deflection limit of girder under rated load plus dead loads.	1/600th of span with weight of crab in central position	

GIS building EOT Crane

The EOT crane shall be designed for the following parameters/duties:meters:

A.	Capacity (in Tonnes)	10 T
B.	Span (s)	16000 mm (approx.)
C.	Normal speeds & with full loads	
i)	Hoisting speed	0-3 m/min

ii)	Trolley Travel (Cross)	0-3 m/min
iii)	Bridge Travel (long travel)	0-10 m/min
D	Max. acceleration/ deceleration of bridge travel & trolley travel.	0.2 m/sec^2
E.	Crane hook vertical travel reach from Transformer bay	16.0 m
F.	Required hook approach limit from Rail center line	
i)	On Upstream	≤ 665 mm
ii)	On Down stream	≤700 mm
G.	Hook reach from the left & right side walls of GIS Building end stops on side walls	≤1500 mm or minimum possible
H.	Runway; Travel lengths	
i)	Gantry rail top level	EL- To be mentioned later
ii)	Length of run way	105 m (approx.)
iii)	Trolley travel length	Max. Feasible for specified crane span shall ensure hook reaches
I. i)	Distance available between rail centre line and column on either side	< 665 & <700 mm
ii)	Head room above crane rail ©	1500 mm (min.)
J.	Factors of safety & Deflections:	
a)	Minimum Factors of safety for Design	
i)	For structural members based on ultimate tensile strength	The factor of safety and stress level shall be as per IS-807-1976 or the latest
ii)	For ropes & slings, based on ultimate tensile strength	6
b)	Deflection limit of girder under rated load plus dead loads.	1/750th of span

E) Workshop Crane

The EOT crane shall be designed for the following parameters/duties:meters:

A.	Capacity (in Tonnes)	
i)	Main	50 T
ii)	Auxiliary	10T
B.	Span (s)	10000 mm (approx.)
C.	Normal speeds with full loads, in m/minute	
a)	Main hoist (50 T)	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

i)	Hoisting & lowering speed	0-3.0 m/min
b)	Auxiliary hoist (10 T)	
i)	Hoisting &lowering speed	0-5.0 m/min
c)	Trolley Travel	0-10 m/min
d)	Bridge Travel (long travel)	0-25 m/min
D	Max. acceleration/ deceleration of bridge travel & trolley travel.	0.2 m/sec^2
E.	Crane hook vertical travel reach from Workshop floor level to upper most position)	**Main Hook** To be finalized during detailed engineering
F.	Required hook approach limit from Rail centre line	**Main Hook**
i)	On Upstream	≤ 2,000 mm
ii)	On Down stream	≤ 3000 mm
G.	Position of Hook from End walls	≤ 3500 mm
H.	Runway; Travel lengths	
i)	Crane beam top level	To be finalized during detailed engineering
ii)	Length of run way	To be finalized during detailed engineering
iii)	Trolley travel length	Max. Feasible for specified crane span and shall ensure hook reaches.
I. i)	Distance available between rail centre line and walls on either side (U/s and D/s) from rail C/L to nearest side obstruction on	1,000 mm
ii)	Min. clearance between extreme point of crane and U/s & D/s side walls.	500 mm
J.	Means for Micro speed for Inching Motion for main lifting hooks.	Step less, frequency converter speed control system
K.	Factors of safety & Deflections:	
a)	Minimum Factors of safety for Design	
i)	For structural members based on ultimate tensile strength	As per IS 807(Latest)
ii)	For ropes & slings, based on ultimate tensile strength	As per IS 807(Latest)
b)	Deflection limit of girder under rated load plus dead loads.	1/600th of span with weight of crab in central position

The EOT Crane dimensions are tentative and shall be finalized at the detailed engineering stage for achieving better dimensions only. The Contractor shall, however, co-ordinate the lifting requirement of machine components for erection with respect to the layout and dimension of powerhouse.

23.3.3 Performance Criteria and Guarantee

The electric overhead travelling (EOT) cranes along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system. The cranes shall be capable of raising, lowering holding and transporting their rated loads without any damage to or excessive deflection of any component.

The following shall be maintained in the operation of the cranes, with all brakes adjusted and functioning correctly and hook carrying rated load. Minimum possible travel/incremental movement are given below:

i. Main Hoist vertical movement 1.5 mm

ii. Auxiliary Hoist vertical movement 1.5mm

iii. Bridge travel 3.0 mm

iv. Trolley travel 3.0 mm

v. Monorail travel 5.0 mm

The total maximum vertical deflections for the girder for the safe weight of working load plus the weight of crab in central position (Without taking in to consideration the impact factor) will not exceed limit of span/750 for crane (if span of the cranes is more than 12m), and span/600 for crane (if span of the cranes is less than 12m) as per IS 807.

23.3.4 Safety requirements

In the design of Crane, all safety regulations as applicable with Factory Acts, Indian Electricity rules or equivalent national / international rules etc. as prevailing in the country and the site of installation shall be taken into consideration and provided for. In the event of extreme variation in supply voltage outside the expected limits defined in "Section 1 - General Technical Requirements", there shall be total load control and measures shall be taken to place the handled equipment in a secure position. Correct vertical motion

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

functioning shall be guaranteed within the abovementioned ranges of expected frequency and supply voltage variation. In the event of a loss of electrical supply, load control shall be ensured. Collisions of trolleys and pieces of equipment with buffers shall not endanger load control.

23.4 DESIGN AND CONSTRUCTION

23.4.1 General

The EOT cranes shall conform to the requirements of the specification and installation arrangement shown in the relevant drawings appended with the specification.

a) The crane shall be of indoor, electrically driven, cage operated, single trolley, double girder, overhead traveling type the cranes shall be M5 duty type and shall be designed in compliance with the latest versions of IS 807 and IS 3177 wherever requirements contained in the latest applicable ISS are stricter than those contained herein , ISS requirements shall govern.

b) The cranes shall be designed in accordance with requirement of these specifications including the limiting and/or mandatory dimensions shown on the specification drawings. The details shall be determined by the Contractor subject to customer's approval

c) Any design feature or detail not specified shall be in accordance with IS:807 & IS: 3177 or other approved standards which shall supplement these specifications.

Cranes conforming to any other International or National Standards shall also be acceptable provided the cranes satisfies fully the technical requirements and intents of these specification.

Suitable devices shall be provided for fixing the various equipments/panels to withstand the seismic events to prevent the movement of foundation. The necessary bolts for embedding in the concrete foundation would need to be supplied by the Contractor for this purpose. It shall be ensured that these special devices as well as bolts shall not be over stressed. The details of the devices used and its adequacy along with the supporting calculations shall be furnished by the Contractor and shall be subject to the purchaser's approval. Seismic forces as per chapter no 1 shall also be considered for design of EOT Cranes.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

23.4.2 Arrangement of Operator Cabins

The operator cages/cabins of the cranes shall be fitted on the upstream side on the non adjacent girders. This arrangement 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.

The crane on the left side of the power house when viewing from downstream shall be designated as crane No.2. The crane on the right side shall be designated as crane No.1

23.4.3 Simultaneous Operation of Hoist (for Power House Crane)

The cranes will be required to handle 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 the components from lying to vertical position using both the hoists, by manipulation of the hoisting and other movements as the case may be.

23.4.4 Tandem operation of two cranes for heavy loads (for Power House Crane)

For handling generator-rotor with shaft or any other heavy equipments whose weights exceed the crane capacity, both the cranes will be used jointly and simultaneously for handling such equipment with the help of a special lifting beam to which both the hoists will be attached. The lifting beam has been specified to have in-built pins for attaching to the main hoists of the 2 cranes.

During joint (tandem) operation, both the cranes shall be coupled electrically and mechanically and all operations and 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. 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 2 cranes shall have provision for coupling mechanically and electrically with ease and reliability for this purpose. When operating in tandem the 2 cranes shall maintain horizontality of the lifting beam in all motions during such operation.

The lifting beam is covered as part of the supplies. The crane hook shall have pin and holes for attaching the lifting beam to the hoist. Coupling arrangement for lifting beam to rotor is covered in the scope of generator. However, interfaces shall be coordinated with the generator section.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The Contractor is responsible for all co-ordination.

23.4.5 Loadings for Crane Design

The cranes and runway rails shall be designed for the following combination of 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 crane and runway rails etc. shall not exceed the safe permissible stresses under any actual combination of loads.

23.4.5.1 Combination of Loadings on crane

1 **Crane stationary/load being hoisted/ beginning to be hoisted**

a) Dead load + Live Load + Vertical Impact Load

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

The resulting stresses not to exceed 90% (ninety percent) of the yield point (elastic limit) of the materials of the members subjected under the loading.

2 **Crane in motion**

a) Dead load + live load + any one horizontal load viz lateral, longitudinal or specific design load.

b) Dead load + braking load.

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

The resulting unit stresses due to loads shall not exceed the safe stresses by more than 35 (thirty five) percent.

3 **Crane Stationary**

Dead load + Earthquake load.

23.4.6 Performance/Quality of Operations

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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The following tolerances shall be maintained in the operation of the crane:-

a) Smooth control of vertical movement within 1 mm for loads up to Main hooks and 3 mm for aux hooks and 10 mm for with hook carrying rated load at a time and hoist brakes properly adjusted for normal operation.

b) Control of bridge and trolley motion to within 10 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 not to exceed 1/900th of the crane span for all Cranes

23.4.7 Fabrication At Works Only

The cranes shall be completely fabricated in the contractor's workshop and no welds on main structures shall be allowed at site.

23.4.8 CONSTRUCTION DETAILS

23.4.8.1 **Structural parts of crane**

A **Crane Bridge**

1 The crane bridge, made of two 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 within 1 mm in 4 seconds.

2 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 sectionalized into suitable but minimum no. of sections within the transport constraints as also of field erection & handling.

3 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.

4 Adequate No. of CO2 gas cylinder of 4.5 Kg capacity each for

fire extinguishing shall be provided on the bridge suitably located.

The bridge shall have the following provisions:-

a) Welded end-stops of steel to act as stoppers for trolley/crane.

b) Heavy rails for trolley supported centrally on girders held in place by rail clips locked in position to prevent creeping of rails.

c) 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 & vibration & skewing of crane on the track.

d) Suitable no. of guide rollers for guiding trolley wheels on rail track.

e) Supporting structure for mono-rail hoist underneath the bridge girder.

f) Access for inspection & maintenance of the 10 tone mono-rail hoist.

B Trucks (End Carriages)

1 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. Two end carriages will be provided on each end of the crane and will be connected with an equalizing beam to take care of any track variation and for equal load sharing.

2 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 sufficient to carry the rated capacity load at specified speed without excessive heating during continuous operation.

3 Wheel assembly 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 4 m, as reckoned between

centers of outer wheels. The end trucks shall be designed to contact end stops.

4 Each truck shall have

a) Double flanged rail wheels with bearings running on suitable axles, fracture props, buffer etc. for easy maintenance.

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

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

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

e) Resilient bumpers or spring loaded buffers on contact faces of end stops.

f) 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.

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

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

i) 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.

5 Arrangement for jacking the cross traverse wheels shall be similar to the one described here. The contractor shall furnish the technical details of jacks to be supplied.

C) **Wheels, Axles and Wheel Bearings**

1. **Wheels**

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

a) The bridge shall be carried on sufficient number of wheel pair on each side as per IS 3177-1999 suitably mounted on trucks and designed so as to distribute the load equally on truck beams & wheels. The wheels shall meet the following requirement

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 forged steel and heat-treated or made of sperodical cast and heat treated to HB-250 and steel should not contain more than 0.060 percent either of sulphar or phosphorus.

iv) Equalized in pairs

v) Flanges tapered and radiused to prevent derailment.

vi) Tread width to have proper clearance and sufficient size to withstand maximum static and moving/ rolling loads.

vii) Bridge and trolley wheels to be identical for interchangeability.

b) The design of the wheel truck assembly shall be such as would allow the wheels to adjust themselves to irregularities of the runway within allowable limits.

2 **Wheel Axles**

The wheel axles shall be as per the following

a) Made of forged carbon or alloy steel.

b) Accurately turned, grounded and polished at the fitting positions in the wheels.

c) Suitable interference fit with the wheels

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

.3 **Wheel Axle Bearings**

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The wheel bearings which shall be interchangeable & easily removable shall comprise the following:-

a) Bearing housings/journals fitted into truck bodies.

b) Self-lubricated type bronze bearings accurately machined to fit into journals/seats in the truck bodies, and correctly bored for the axles, or

c) Roller bearings with high pressure grease lubrication.

D) **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 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.

E **Operator Cabin, Walkways, Ladders and Safety Guards**

.1 **Operator Cabin**

The operation of the crane will be from driver's cabin suspended under the bridge and will house all the control equipment for the operation of the crane. The cabin of structural steel frame shall be designed and constructed in accordance with the following requirements :-

a) Enclosed type for indoor service, having adequate working space for operation & maintenance.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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

c) Floor of steal plates securely connected to the frame and covered with matting.

d) Located on the up stream side of the bridge of the crane, and suspended from their outside girders.

e) Railing on all open sides, a ladder for access to the crane bridge walkway, a 5 kg CO^2 portable fire extinguisher.

f) A cut off switch near the cabin for disconnecting the incoming power supply before entering or leaving the cabin for operator safety.

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

h) Fan

.2 **Walkways and Ladders**

Ladders, platform, walkways, hand holds, etc., necessary to give safe access to any 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 as per the following requirements :-

a) Walkways to be of steel checkered plating for full bridge length, at same elevation as that of bridge attached but outside each girder. The width, clearance from drive units and head room are to be minimum 700, 500 and 2000 mm respectively.

b) 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 3 meters.

c) Hand rails for walkways, platform, stairs, ladders, etc. shall be 1100 mm with an intermediate rail.

d) Two plates on each side edge of all walkways shall be about 100 mm height.
e) Special provision of ladder and walkway upto monorail shall be designed and install for access and maintenance.

.3 **Safety Guards**

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

a) For gears, chain drives : encasements

b) For revolving shafts & couplings: guards for full lengths.

c) For sheaves of hook block and rope: guards to prevent trapping of hand and rope from dismounting from sheave grooves even if rope slackening develops.

d) For opening in foot Walk floorings and other inspection platforms: Covers of lockable type.

F Lifting Beam

a) The lifting beam required for lifting generator rotor or/ and generator stator shall be supplied by the Contractor.

b) Lifting beam is required for handling the generator rotor, generator stator or other parts having a weight of more than 200 Tonnes, requiring the use of two cranes working together. The weight and dimensions of the lifting beam shall be within the transportation limitations. It shall have a rated capacity to be established by the Contractor to handle the generator rotor and generator stator. The lifting beam shall have in built pins for attaching to the main hoists of the two (2) cranes.

c) All connections between the lifting beam and lifting devices/attachments for the generator rotor/station etc. shall be so arranged that when the lifting beam is attached to the main hoists of the cranes, the generator rotor/stator with the shaft shall remain in a vertical position and shall be free to turn upon its vertical axis. The horizontality of the beam shall be maintained when it is lowered or raised. Suitable roller type bearings shall be provided for the load support. The final lifting arrangement for the components requiring use of lifting beam etc. shall however be finalized in consultation with the generator manufacture. The lifting beam shall be provided with suitable arrangements (such as mercury limit switch) to check the horizontality of the beam when it is attached to the cranes. For this, balance indicator is to be provided on the lifting beak to show that the beam is horizontal at all times.

d) The lifting beam with pins/slings shall be adequately designed for handling the rotor weight. The spacing of the lifting trunnions shall be finalized in consultation with the generator Contractor. The total length of the lifting beam shall be determined taking into consideration the shortest distance available between the two main hooks of the cranes when operating in tandem.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

e) Necessary drawings or lifting arrangement or stator and rotor along with attachments for lifting these items shall be supplied by the generator Contractor.

23.4.9 **Mechanical Equipment Details**

23.4.9.1 **Bridge Travel Mechanism**

.1 This mechanism shall comprise of 4 (four) electric motors and totally enclosed speed reduction helical gear unit, 2 (two) for each end of the bridge, to drive the 4 (four) bridge wheels and shall ensure equal speed.

.2 The gear motors shall be keyed directly to the extended wheel shaft.

.3 The bridge motion shall be free from vibration, rocking etc. under all conditions of operations and the crane structure shall not have any tendency to get out of line.

23.4.9.2 **Trolley Travel Mechanism**

This mechanism shall comprise of electric motor preferably 2 for Cranes and totally enclosed speed reduction gear unit, 1 (one) for each end of trolley to drive two trolley wheels, designed to ensure equal speed and steady motion, free from vibrations and rocking.

23.4.9.3 **Hoisting Mechanism for Raising and Lowering of Loads**

The hoisting mechanism provided and mounted on the crane trolley shall comprise of Motors, Speed reduction gear units for normal speed, Drums, Brakes, Lifting tackles and hooks, hoisting ropes and slings as below.

1 **Hoist Drive For Normal Speed**

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

2 **Hoist Drive For Micro Speed (Inching)**

a) 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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

vertical motion of the hoist within 1 mm.

b) The inching operation shall work for both individual as well as for tandem operation of the 2 cranes.

3 **Change over device**

The hoist shall be driven on two different speeds. Suitable capacity change over device will be provided by the bidder.

.4 **Winding Drum**

The winding drum shall be made of cast steel conforming to relevant IS. The winding drum shall have machined grooves to receive the full hoisting rope without overlapping and the drum shall be of such size that there will not be 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 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.

.5 **Lifting Tackles and Hooks**

a) 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 for Cranes
.

b) Sheaves shall be made of cast steel and shall be machine grooved to a depth of not less than 1.5 (one and one half) 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.

c) The swiveling hook shall be of forged steel and mounted on ball thrust bearings and protective skirt shall be provided to enclose the bearings for power house and PPV cranes.

d) The Main hook shall be of the Ramshorn type for e cranes . Auxiliary hooks for cranes shall be shank (single) type conforming to approved relevant standards.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

.6 **Hoisting Ropes and Slings**

a) The hoisting ropes for main and auxiliary hoisting shall be rated core 6x36 type construction or equivalent or better type with independent wire rope core and regular lacy construction. The rope ends shall be anchored by clamps securely attached to the drum. The factor of safety for the hoisting ropes shall not be less than 6 (six). The rope system shall be equalized and arrangements entailing reverse bends shall be avoided as far as possible.

b) The Bid shall include requisite wire rope slings of suitable lengths having a safety factor of not less than 6 (six) when lifting specified load with the angle formed at the hook not less than 90 degrees. A minimum of five pairs shall be provided for different loads up to the rated capacity of hoist. The slings shall be suitable for use with hoist.

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

d) 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 fixed label on which is stamped the maximum safe lift at 90 deg spread. A storage rack for the sling shall be provided.

.7 **Mono-Rail Hoist (for Power House Cranes)**

The mono-rail drum type hoist shall be installed underneath the non-adjacent girders of the two cranes which shall be electrically operated from the operator cabin of each crane both for hoisting and across travel having two speeds. The speed changing system shall be of commercial design. The hoist shall be compact, dirt and dust proof. The travel wheels shall be machined. Gear reduction may be helical. High and low limits to lift shall be provided. The mono-rail shall be provided with end stops.

23.4.9..4 **Brakes For Various Drives/Motors**

.1 The brakes for various motion drives shall be as per the FEM standards. The following type of brakes shall be provided for the various crane drives:

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

a) Bridge Travel:

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

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

iii) Automatic EH Thruster brakes for each motor drive end

iv) Double (2) brake discs attached to the DC electro magnetic
Brake.

b) Trolley Travel:

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

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

iii) Automatic EH Thruster Brakes

iv) Double (2) brake discs.

c) Hoisting Motion:

i) Main Hoist

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

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

c) Automatic Electro Hydraulic Thruster brake

ii) Auxiliary Hoist

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

b) Automatic DC electro-magnetic brake for each motor drive double (2) brake discs.

c) Automatic Electro Hydraulic Thrust Brakes

d) Mono rail hoist

i) Hoisting motion — Automatic DC EM brake

ii) Travel motion (along bridge) — Automatic DC EM brake

e) Micro Speed Drive Motor

a) Automatic Electro Hydraulic Thruster Break (reverse action type)

.2 The electromagnetic brakes shall be of DC type complete with rectifier equipment to convert the available 240 V AC, 50 HZ supply. The electro-hydraulic thruster brakes shall be AC type.

.3 The operating solenoids of the EM DC 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.

.4 The EM DC brakes shall be of spring set shoe type equally effective in both directions of rotations. The springs for the EM brakes shall be of compression type and shall have adequate factor of safety.

.5 The brakes system shall have the following provisions :-

a) Locking device in the brake lever.

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

c) Emergency stop push buttons.

.6 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 for power house and PPV cranes. 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 (245 N) 25 Kgf.

.7 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.

.8 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.

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

.10 The brake torque may be increased, if considered necessary by the manufacturer in order to ensure proper and safe application of the brakes. All EM brakes coils shall have continuous rating.

23.4.9.5 **Gears**

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

a) Spur and helical gears only to be used for speed reduction gearing. The tooth profiles to be carefully designed and machined.

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

c) To be made of cast steel or wrought steel & designed for the specified crane duty.

d) To be totally enclosed in oil tight gear cases of weld fabricated steel.

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

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

g) Oil level indicator.

h) Proper guards for gear in case not enclosed in gear cases.

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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

23.4.9.6 **Shaft**

The shafts for various purposes shall be designed and made in accordance with the following :-

a) Material- high tensile rolled steel.

b) Shaft diameter to take into account the key slot & splints. Slot bottom to have proper rounding off.

c) Designed with shoulders/raised portion for carrying & fitting of gears, pinions & other similar parts.

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

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

23.4.9.7 **Bearings**

The bearings for various purposes shall be designed and provided in accordance with the following :-

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

b) Bearings to be located close to the points of loading & to be designed so as to be easily replaceable type.

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

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

23.4.9.8 **Lubrication Arrangement of Bearing, Journals, Ball & Roller Bearings**

The arrangement shall comprise of the following :-

a) Pressure lubrication system comprising gun for lubrication of

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

all easily accessible grease type bearings provided 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 to be double lines for ensuring continuous lubrication in case one line gets choked.

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

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

e) Initial lubrication of crane before handing over is contractor's responsibility which shall be done in presence of Purchaser.

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

g) Specification and details of lubricants, Indian standards or equivalents thereof shall be furnished by contractor.

23.4.9.9 **Drip Pans And Covers**

.1 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.

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

23.4.9.10 **Bumpers**

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 spring bumpers on each side placed to ensure that the track stops squarely at the end of the stops. The bumpers shall consist of suitable resilient type capable to absorb the moving energy as per FEM standard.

These shall be fastened to the trucks and the trolley, 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.

23.4.9.11 **Holding Clamps Against Earthquake**

As a safeguard against movement of the crane off the rails during an earthquake, suitable provision to contain the movement of the crane shall be made. Clamps to keep the crane in locked condition while not in operation shall be provided.

23.4.10 **Electrical power drive equipment details**

23.4.10.1 **General**

.1	The electrical drives, switchgear and controls for various motion for the crane shall comprise of electric motors of requisite capacities for specified duties and speeds, Switches, Breakers, Electromagnet Brakes, Isolating Switches, Controllers, Earthing, Cabling/ Wiring, and other in accordance with IS: 3177-1977.
.2	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 240 V, 1-phase, 50 Hz AC and shall be obtained through individual 415/240V transformers, wherever necessary. All electrical equipment shall be suitably designed and constructed for operation under tropical conditions.
.3	Permissible temperature rise of the electric motors and individual components of associated switchgear equipment shall be as prescribed in the Indian Standards or corresponding International Standards and based on ambient temperature of 40 deg.C.
.4	The electrical control and operating mechanisms and devices shall be located and arranged in a neat and convenient manner which shall be subject to the approval of the Purchaser. Crane control levers, motors, switches and other operating mechanism shall be marked plainly and permanently.
.5	The technical particulars of various electrical equipment and devices shall be as specified here in. The contractor shall furnish the make, type and other relevant details of the various electrical equipment and devices being offered by them.
.6	Frequency converter control units should be provided individual crane operation and for tandem operation of both cranes

23.4.10.2 **Detailed specification of individual equipment**

.1 **Motors For Various Motions**

a)	Motor Standards	As per IS:325-1970 & 3177-1977
b)	Capacity	Of ample capacity to withstand respective duties. Full load torque of motors to be higher than the maximum load torque.
c)	Type & Enclosures	All motors should be squiral cage type to suit 415 V AC, 3 phase, 50 HZ, 4 wire power supply system and be totally enclosed type with or without fan cooling arrangement. The motor 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.
d)	Variation of voltage & frequency	Voltage ± 10% Frequency: ± 3% Any combination values of voltage & frequency variations up to above limits.
e)	Pull out torque	Not less than 2.25 times the full load torque of motors at rated voltage and frequency.
f)	Insulation	Class-F.
g)	Time Rating	One hour for all motors. .
h)	Temp. Rating	Temperature rise not to exceed the limits in Table 1 of IS: 325- 1970. Max. Temperatures rise at full load measured by resistance method shall not exceed 60 ^{o}C over the average ambient temp of 40 ^{o}C .
i)	Rated syn.speed	To suit duty for various motions.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

j)	Over speed with stand capacity	2.5 (Two point five) times rated speed or 2000 rpm which ever is lesser.
k)	Space heaters	To be provided in case motor capacity is ≥ 20 kW (To suit 240 V AC Supply).
l)	Motor Bearings	Roller or ball type. Sealed to prevent grease leakage & entry of dust. Of ample strength to withstand heavy shocks & vibration to which subjected under all conditions of operation.
m)	Tests	Type & routine tests as per IS:325 - 1970. Copies of test reports to be furnished by the contractor.
n)	Temp. rise measurement	By resistance method.
o)	Climate	To be located indoor in tropical climate to be provided with protection against fungus, vermines, and corrosion.
p)	Terminal	To be arranged such that terminals are easily accessible for inspection and maintenance. Natural ventilation is not to be restricted.
q)	General	Sturdy and strong to withstand shocks and vibrations to which they get subjected.

.2 **Limit Switches**

a) For each type of crane Limit switches for hoisting motion shall be of spindle type while for bridge and trolley motions, these shall be of liver/roller and proximity type with maintained contacts. The number of limit switches shall be as under :-

Motion/ Travel	Travel	Raising	Lowering	Emergency 'up' limit

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Main Hoist	-	1	1	1
Auxiliary Hoist	-	1	1	1
Bridge	2	(Two way self resetting type)		-
Trolley	2	(Two way self resetting type)		-
Monorail	2	1	1	1

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

23.4.10.3 Electrical controls and protection for operation of cranes

General

For Power House Crane:

The cranes shall be provided with control gear located in the operator cabin from where it shall be normally operated by the operator. The control gear shall provide for

a) Individual independent control of the 2 cranes for all motions and various speeds up to normal speeds.

b) Tandem operation of the 2 cranes when coupled electrically and mechanically for lifting heavier equipment weighing more than 200 T.

Control Switches, Levers and Speed Controls

.1 For individual independent control (start, stop and motor speed selection) of the cranes, lever type switches shall be provided.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

.2 The controls shall provide for torque and speed control of the various motors in following number of steps in both direction of motions:

		Hoisting	Long Travel	Cross Travel
a)	Main Hoist Motor	Stepless	-	-
b)	Bridge Travel	-	Stepless	-
c)	Cross Travel	-	-	Stepless

.3 The trolley travel controllers shall be provided with drift points in both directions of travel.

23.4.10.4 Speed Regulation

Speed regulation shall be accomplished utilizing a VVVF drive control system for all crane motions. The hoist and travel motions shall be provided with step-less speed-regulation from 5% to 100% of rated speed. Speed control shall be achieved by adjusting the frequency of the motor electrical supply using thyristors. (Combination of Power Rectifier Bridge and Inverter)

The maximum acceleration produced by the control system shall be independent of the rate of change of the control lever position. The speed in the first lowering position shall not exceed 5% of the synchronous hoist speed when lowering any load up to rated load. 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.

23.4.10.5 Tandem Operation (for Power House Crane)

.1 For tandem operation of the two cranes master control equipment arranged in a manner to provide convenience and view for the operator shall be provided, in the operator cabin of each crane to enable tandem operation of the cranes from either of the two cabins. In this operation one crane shall act as the master and the other shall act as the slave, for all the drives/motions.

.2 Further the speeds of the various motion at all steps for both the cranes shall be identical accordingly the ratings and characteristics of the corresponding motors shall be same.

.3 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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

him to stop the motor without time delay from any position of the master switch.

23.4.10.6 **Operation of Brakes**

Whenever power supply to the various drive motors for various motions are 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 lowering direction.

23.4.10.7 Electrical Interlocks

.1 The main circuit breaker (CB) for power supply to the crane shall have interlock providing circuit breaker 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 though the control lever switches have been brought to the OFF positions, the circuit breaker will not close.

.2 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 death of the operator while operating the 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 .

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

.4 An isolator fitted on the crane bridge which can not be operated from the floor shall be provided to prevent inadvertent operation of the crane from the floor from pendant switch while maintenance work is being carried out on the crane.

The controls shall have following provisions :-

a) 3 pole 415 V AC, ACB with rupturing current not less than 20 kA.
b) A master push button for complete emergency stop in the cabin at a convenient location for cranes

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

c) A key operated electrical switch for the control circuit to prevent unauthorized operation and for the safety of maintenance and operation 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) The radio control push button station with proper indication.

23.4.10.8 Automatic Electrical Protection

The Electrical equipment and circuitry shall be provided with required automatic protection against various faults and mal-operations of the equipment as detailed below:

a) Protective relays for protection against instantaneous over-current, over-load, single phasing and under voltage for all motors. The OC relay to be adjustable between 2 to 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) Double pole fuse switches for control and protection of all motor circuits.

d) 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 20 KA with short circuit, overload & under voltage trip devices and one shunt trip coil and prevention against single phasing, 3 timer relays.

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.

g) An emergency push button shall be provided in the operator's cabin in all the cranes for emergency tripping. The push button shall be arranged as to immediately cut-off the main supply and apply all the brakes simultaneously irrespective of controller position.

23.4.10.9 Particulars of control gear for equipment

.1 **Motors**

a) Controls for various motors shall be full magnetic reversing type with definite time limit and frequency controlled acceleration devices for power house and PPV cranes.

b) The motors speed changes may be provided by thysistor or static or magnetic method for cranes.

c) Master switches for operation shall be vertical type lever handle design pointing in the actual direction of the performed motion when operated. They shall be labeled indicating directions of motion for which they are meant for cranes.

.2 **Resistors**

a) All resistors shall be non-breakable, corrosion resistant crane duty, stainless type having low temperature coefficient. The resistor classification shall be in accordance with the National Electrical Manufacturer's Association (NEMA) standard, USA or the corresponding British Standard or any equivalent. The resistors shall be placed in accessible places outside the cages and in well ventilated non-combustible cabinets which will not emit flame.

b) The resistor shall be of continuous duty for hoist motor. The resistors for bridge travel and trolley travel shall have at least 10 (ten) minute rating.

c) The general arrangement of the resistors shall be such that a defective bank of elements or part thereof may be easily removed and replaced without being completely dismantled.

d) Tapping shall be connected by copper rod or strap to an accessible terminal board at the base of each frame. Provision shall be made for making a connection to any grid of each resistor.

e) The controllers and resistors for motors shall comply with BS: 587-1957. The contactors and starters shall conform to IS: 1822-1967 and IS: 2959-1965 and shall be continuously rated for 150% full load current of motor.

.3 **Circuit Breaker/Controllers**

Each main supply circuit breaker or contactor shall have an interrupting capacity of not less than 40,000 amperes for higher rating cranes and 10,000 amperes for 10 T crane 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 higher rating cranes for one second without injury and shall have a rating of at least 660 volts and capacity ratings in accordance with the British Standards or IEC. Allowable temperature rises shall be as prescribed in the Indian or other equivalent standards and based on an ambient temperature of 40 deg.C.

.4 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 cabin. For wiring suitable terminal blocks complete and ready for making external connection shall be provided. The cabinet shall be tropicalized.

5. An emergency push button shall be provided in the cabins of cranes for Emergency Tripping. The push button shall be arranged as to immediately cut off the main supply & apply all brakes simultaneously.

23.4.10.10 Power supply tapping and other electrical arrangement

Collectors

The collectors shall be designed to reduce the 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.

Trolley conductors

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

23.4.10.11 Down Shop Leads (Main Runway Conductors)

.1	A safe, robust and compact down shop leads (DSL) system with suitable collectors using latest technology shall be provided for each crane location and length as specified in clause 12.2. It shall consist of substantial rolled copper section conductors of adequate capacity shrouded in a rigid PVC cover. The copper bar section shall be supplied with connecting pins for proper joints. The hanger clamps for holding the down shop leads shall be plastic moulded standard interlocking snap-on type. The collectors shall be standard mount for use on straight bar system.
.2	The contractor shall verify and satisfy himself about the adequacy of leveling & grouting etc.

23.4.10.12 Wiring

All electrical wiring shall conform to IS: 1554 (part-I)- 1964 "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 motors 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 and of suitable sizes. All the wiring shall be subject to approval of the Purchaser. All wiring shall be laid in hot dip galvanized metal conduits.

23.5 AUXILIARY SYSTEM AND MISCELLANEOUS COMPONENTS

23.5.1 Illumination and convenient outlets

The permanent AC illumination system on the crane shall consist of four 1000 watt highway beamed flood lighting units to illuminate uniformly the area under the crane. Sufficient and redundant illumination with latest state of art technology should be provided in operator's cabin to illuminate uniformly the operator's cabin. A convenient outlet at each end of the bridge shall also be

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

provided. The system shall be supplied from 415 V AC crane power system through 415 V circuit breaker. For lighting and convenient outlets, 4 branch circuits shall be taken; one connected to two 100 watt lights in the operator's cabin, other two branch circuits each connected to two 1000 watt highway lights and fourth branch circuit connected to four convenient 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. A portable hand lamp with plug & 25 m long wire shall also be supplied by the Contractor.

23.5.2 Earthing

.1	The crane structure, motor frames and metal cases of all electrical equipment including metal conduits or cable armoring or guards shall be efficiently bonded to facilitate earthing as per latest edition of Indian Electricity Rules 1956 and latest edition of IS-3043.
.2	The contractor 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 or the PPV earth mat to be laid by the Purchaser.

23.5.3 Rails and other Miscellaneous Items

23.5.3.1 Runway Rails

.1 One (1) set of runway rails complete with sole plates, anchor bolts, clamps etc. for the bridge travel shall be designed and supplied by the contractor.

.2 The runway rails shall be CR-100 type.

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

.4 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 angle of 45 degrees to the length to provide oblique faces between rail lengths to prevent jerking of the crane bridge while crossing the gaps.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

23.5.3.2 Towing Equipment (For Power House Crane)

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

23.5.3.3 Anti-collision devices (For Power House Crane)

.1 Provision of suitable anti-collision devices to prevent the collision of the two cranes shall be made.

.2 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.

23.5.3.4 End Stops

Suitable end stops shall be provided for the crane to be fixed either on the end wall faces or on crane beams. Load cell arrangement as given in the clause 15.12 of IS 3177 for all the cranes shall be provided.

23.6 DRAWINGS, DOCUMENTS AND DESIGN CALCULATIONS

After award of contract, the contractor shall furnish all drawings, documents, design calculations, data, manuals & other necessary literature, pertaining to equipment offered by them & so specified under various clauses, in accordance with requirements stipulated in "clause 1.19 of Section – 1 i.e. General Technical Specification (GTS)". A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand for approval of the purchaser as already explained in clause no. 1.19.6 of Section – 1 (GTS). The list of drawings & documents to be furnished for approval / reference shall not be limited to the following:-

i) Drawings, documents, design calculations literatures, manuals etc. as per clause no. 1.19 of Section-1 (GTS)

ii) Drawings, documents, design calculations, literatures, manuals as listed in Annexure – D of Section -1 (GTS) referred under clause no. 1.19.6

iii) Detailed quality assurance plan, giving complete specifications of the materials and specifications relating to inspection and testing of materials and finished components.

iv) All drawings having bearing on civil foundations, equipments foundation details and loads

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

v) Arrangement, installation, foundation, plan, section, detailing of main equipment and sub-assemblies including piping, control & instrumentation system.

vi) All Electrical, Hydraulic & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of this section.

vii) All manufacturing drawings not specifically covered under approval/reference category shall be submitted for record and facilitate inspection of the component in the shop and assembly at site.

viii) Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work.

23.7 SHOP ASSEMBLY, INSPECTION AND TESTS

23.7.1 Shop test

23.7.1.1 Testing of Crane Assembly

All the cranes shall be completely assembled, inspected, operated and tested in the shop. The crane shall be tested, both for hoisting and cross traverse motion. Travelling gear shall be run light to check shaft and gear alignments. The tests shall cover but shall not be limited to the following:-

i. Overall inspection of crane, dimensions, spans, clearances, hook reaches and ratings.

ii. Main hoist lifting motion with test load of 100% and 125% of rated load.

iii. Auxiliary hoist lifting motion with test load of 100% and 125% of rated load

iv. All other tests as mentioned below.

a) Part-I De-energized Tests

i) Steel Structure
ii) Bolts and Nuts.
iii) Securing devices for all wire ropes.
iv) Crane Cabin-Platform.
v) Gangway.
vi) Surface/Painting.
vii) Boggies - Traveling Wheels.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

viii) All Main Hooks W / Housing and Safely Latch.
ix) All aux Hooks W/Housing and Safety Latch.
x) Bolts for all motors.
xi) Inspection of spare parts.
xii) Insulation tests of various drive motors.
xiii) Air gap of brakes measurement.
xiv) Examine wire ropes.
xv) Inspect clean and oil all moving mechanical parts.
xvi) Check oil level in hoists and traveling motors gearboxes and 'top-up'.
xvii) Check and grease rope guide und drums.
xviii) Check and examine cable trolley, track system, moving and connection parts.
xix) Check bus-bar suspension bolts, brackets and current collectors.
xx) Check and examine all e1ec1rical control panel cables, connection terminals.
xxi) Check and examine all contactor and thermal protection device
xxii) Check cable glands and insulation of cables.
xxiii) Setting on the control card (APC, exi. I/O comm.). if applicable
xxiv) Clean up dust and oil.

b) Part-II Energized Tests

i. Testing of the APC and exi. I/O boards, if applicable.
ii. Testing of the digital inputs/outputs, if applicable
iii. Testing of the analogue in puts, if applicable.
iv. Testing or the control panel function.
v. Testing of the lights.
vi. Testing of the anti-condensation heaters.
vii. Testing of the phase order of the 415 V AC.

c) Part-III Function Tests (No Load)

i) Testing of the fault panel functions.
ii) Simultaneous operation of main and aux. hoists.
iii) Travel and hoisting operations.
iv) Working range.
v) Control of limit switches.
vi) Test of emergency Slop.

d) Part-IV Deflection Test

i) The deflection test shall be carried out with the safe working load at rest and with the trolley in a central position. The measurement shall not be taken at the first application of the load. The datum line for measuring the deflection should be obtained by placing the crab on the extreme end of the crane span with smaller hook approach. The

vertical deflection caused by the safe working load and weight of crab in central position shall not exceed the limits specified in the relevant standards.

e) Test certificates in respect of rail , sole plates, clamps etc.as per the relevant IS

23.7.2 Field test

All field tests including tests during installation. Pre-commissioning, commissioning, performance & field acceptance tests shall be conducted by the contractor, in presence of representatives of the employer.

Test on Rails

i) Leveling and alignment of sole plates

ii) Measurement of span, diagonally, straightness, waviness, (horizontal and vertical) as per approved drawings.

B No-Load Static Tests

i) Checking of gears, bearings, couplings and rotating parts for proper oil level or lubrication and hydraulic brakes for brake fluid

ii) Checking of the controller for each motion to ensure that hook and travel motions is in accordance with marked controller directions.

iii) Checking of satisfactory operation and to determine if lamp fixtures on each bridge walkway are operable and convenient for relamping.

iv) Measurement of throat openings of the hooks &, checking with respect to dimensions furnished by the supplier.

v) Overall inspection & verification of crane dimensions, clearances, hook reaches & other important items.

vi) Verification of insulation resistance for electrical equipment and wiring circuits.

vii) Operational tests on each controller, switch, contactor, relay and other control devices including limit switches.

viii) Operational tests on all protective devices.

ix) Tests for checking correctness of all circuits, interlocks and sequences of operation.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

C No Load Operation Tests

i) Each hoist will be run in both the hoisting and lowering direction for the full length of the hook lift until the limit switches stops travel. Both upper and lower limit switches will be checked for proper setting (for resulting hook elevation and amount of rope remaining on drum after switch stops travel) and operation. The additional liver travel limit switches will also be checked by temporarily by-passing the action of the normal upper limit switch. Each hoist will be checked to determine whether the hooks operate within the specified maximum speed ranges. At least two (2) complete raising and lowering operations will be made for EOT hoist at maximum speed. Proper alignment, quiet operation and any major tendency toward overheating of motors, hearings und gear drives will be checked. Hoist brakes will be checked to determine whether they are functioning properly.

ii) All hook approaches, both the side approaches to the rails and the end approaches to the end walls, will be checked for conformance to approved shop drawings and the requirements of these specifications. The limit switches shall allow the specified hook approaches or better approaches.

iii) The trolley will be run in each direction of travel for at least four (4) complete cycles of trolley travel to disclose any tendency towards noisy operation and misalignment at bearings, gearing or motor. The trolley shall be checked to determine whether the trolley travels at the required speed. The motion of the trolley upon setting the controller to the "off" position shall he checked to determine whether the travel brake correctly stops the trolley.

iv) The bridge drive shall he run in both directions of travel for the full available length of runway. The test will consist of a check for quite operation as well as a check of both the electric and hydraulic brakes. The bridge shall be run at full speed in both directions to determine whether the drive operates within the specified maximum speed range. The electric brake and drift points shall be checked for smooth and effective operation.

D Rated Load Tests

a) Hoist

i) With each hoist loaded with its rated load to tests outlined under *'No-Load Operation Tests"* above shall be repeated except for the additional block-operated over travel limit switch operation need not be rechecked. The operation of the electric hoist brake shall be carefully checked. All components shall he checked for overheating, Operating speed on the maximum speed point shall be checked and recorded. The maximum lowering speed will he checked to ensure that it is not more than 125% of the no-load hoisting speed. The control system will be checked for proper

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

operation. The first speed point shall he checked to ensure that it does not exceed 5% of the no-load hook speed in the lowering direction and 25% in either direction. The entire hoist shall be checked for overheating after completing the hoist and lowering cycle with the test load.

ii) The loaded hoist shall be checked to determine whether the hoist control and the solenoid brake satisfactorily control the handling of the load. The hoist must demonstrate its ability to raise, lower and hold the rated load in any position.

b) Trolley Travel

The tests outlined in "No-Load Operation Test- iv)" above shall be repeated for the trolley with the hoists loaded with their rated load.

c) Bridge Travel

The tests outlined in *"No-Load Operation Tests*- iv)" above shall be repeated for the main hoist loaded with their rated load.

E **Overload Tests**

a) Hoists

With each hoist loaded with 125% of rated load, the hoist will be checked to determine whether it can raise, lower or hold the overload in all speed positions without a drift. Each hoist will be checked to determine that the load shall not lower on any hoisting position. The throat openings of all hooks will be remeasured and recorded after the overload test and compared to the initial measurements to be checked for deformation.

b) Bridge

The: bridge structure shall be checked for excessive deflection while loaded with125% of their rated capacity with the trolley at the center of the crane span.

c) Travel

No trolley or bridge travel shall be required during overload tests.

F **Test Load Frames**

a) The supplier shall design, submit shop drawing, manufacture and deliver suitable cradle or a test load frame and all required slings to be used for the rated load and overload tests on each of the cranes to be furnished. The test loads will be made up of steel test weights or any other suitable material and shall be arranged by the contractor including all logistics and transportation. Standard sizes of semi finished steel ingots or slabs can be used as test weights.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

b) The powerhouse crane shall be completely tested as described above, including the rated load test and the overload test. Test load frames shall be provided for all the Load test required such as the testing of the tangs of sister hooks and centre pin holes in sister hooks. Each crane shall have its hooks tangs tested first for the rated load test.

c) The test load frames shall be designed to support a sufficient quantity of steel or concrete test weights for the required load tests. The design of the frames shall make allowances for varying heights as well as for other possible deviations in the overall dimensions of the steel test weights, The test load frames shall he designed at the same stress levels us the crane structure.

d) All pins or other devices for attaching the frames to the hooks and slings and other required accessories for all required tests shall be provided.

e) The test load frames shall be shop assembled to assure proper fit during field erection

f) All structural components of the test load frames shall be cleaned and painted with one coat of primer.

g) The following tests shall be carried at site in addition to the tests indicated above

A **De-Energized Tests:**

i) During commissioning at site

B **Deflection Test**

Deflection of girders with full loads on all cranes to be determined using theodolite or other optical instrument after load has been applied for 15 minutes.

C Tandem operation test for Power house crane including anti-collision test.

i) Electrical and mechanical interlock checking
ii) Movement checking with tandem beam

23.7.4 Performance testing

After completion of commissioning tests and commissioning of respective cranes, these shall remain in the contractor's custody for erection activities till the commissioning of last generating unit. The contractor shall be responsible for maintenance (providing manpower, consumable, spares etc.) of EOT Cranes including rails and operator during this period.

The contractor shall make good any damages and do the capital maintenance

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

of cranes at the time of commissioning of the last unit.

If nothing unusual is observed after capital maintenance, the test service period of seven days shall follow. During the test service period, the cranes must perform satisfactorily.

The contractor is responsible for the equipment during the test service and also for the way it is operated. However, Employers' personnel shall operate the equipment under the guidance during the test service period

During this test service period, the system / installations must perform satisfactorily & if any defects are observed , same shall be rectified by contractor without any financial implication to employer.

23.8 PACKAGING, ~~HANDLING & SITE STORAGE~~

The contractor shall be liable for all packing, ~~handling and site storage~~ of all the equipment till the installation is handed over to the Engineer in charge.

23.9 SITE INSTALLATION AND COMMISSIONING

REFER SUPERVISION OF E&C UNDER SCOPE OF SERVICES

23.9.1 General

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

The Contractor shall provide and install the concrete inserts/embedment; support steels and/or components for foundation /supports purpose, shall do any chipping / leveling works , denting / painting etc.

The Contractor shall supply sufficient number of erection and commissioning spare based on their experience so that erection, testing and commissioning work progresses smoothly and is not hampered for want of such spares. These spares shall be in addition to the spare arts described under clause "Spare Parts".

23.10 TOOLS AND INSTRUMENTS

23.10.1 Tools for erection and Installation.

The Contractor shall bring his own tools, devices, testing instruments / equipments to site in order to erect and install the complete equipment delivered under this section. These shall remain the property of the Contractor unless otherwise agreed to take over any / all of these at mutually agreed conditions.

~~23.11 SPARE PARTS~~

REFER SPARES MENTIONED UNDER MMAINTENANCE SERVICES

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

23.11.1 Mandatory Spare Parts

The Contractor shall supply the mandatory spare parts as per Schedule-III.

23.11.2 Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts at Schedule-IV.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.6 Standards

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

Further rules, guide lines and standard laid down by International/ national agencies shall be applicable in this specification.

List of standards is attached at annexure C.

1.7 Logistics

The Contractor shall establish facilities i.e. office, wireless communication system, internet facilities for smooth and effective monitoring of ongoing activities at site.

1.8 Electrical Works

General Information:-

- Dimensions of Panel, Kiosk, Marshalling Box, Junction Box.
- Weight of above
- Lifting arrangement (All arrangement shall be made through hooks only)
- Baseframe (Suitable for anchoring through anchor bolts in embedded foundation channel)
- Pushbuttons, Indicating lamps, indicating instruments, recording instruments shall be from same supplier throughout the EM Package.
- Numerical relays and Electromagnetic relays shall be from same supplier respectively throughout the EM Package.

1.8.1 Power Supplies

1.8.1.1 AC power

Three-phase system with grounded neutral for feeding three-phase and one-phase consumers (connected between phase and neutral), 415/240V ± 10% and 50Hz ,-5% to +3 %. All motors and other electrical apparatus should be designed to work continuously under,-5% to +3 % frequency variation and ±10% voltage variation.

1.8.1.2 DC power

DC Systems, ungrounded, with earth fault detection 220V plus (+) 10% and minus (-) 20% for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials loads.

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

1.8.2 IP requirement

IP requirement shall be based on applicable National/ international standards and the same shall be finalized during detail engineering. However the minimum requirement shall be as under or as specified in the particular technical specifications of various componenets:

- The cubicles and enclosures shall be of protection class IP 42 or higher according to their location.
- For outside installation and area which are humid, corrosive, and prone to dripping and/ or spray of water, the protection class of cubicles shall be IP 65.
- Cubicles housing electronic cards/modules such as of unit control boards/local control boards, digital governors, static excitation equipments shall be of protection class of IP 52.

1.8.3 Cabling & wiring

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be single / stranded copper subjected to prior approval by purchaser during detailed engineering and shall not be smaller than 2.5 Sq. mm, except as otherwise agreed by the purchaser.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

All Distribution Boards, Control & Protection panels, Motor Control control panels etc. shall be supplied completely wired internally up to the terminal blocks ready to receive purchaser control cable.

All inter cubicle and inter panel wiring and connections between panels of same Distribution Board, Control & Protection panels, Motor Control panels including all bus wiring for AC and DC supplies shall be provided by the tenderer.

Larger size wiring shall be used where needed for the current carrying capacity requirements.

Cables shall have at least 1000 V PVC insulation except for 220V DC and telemetering or communication system equipment for which 650V and 300 V ratings respectively are acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 4.0 Sq. mm.

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 wire ways accessible from the front door.

Engraved core identification ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire.

Each cubical 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.

1.8.4 Power outlets

Power outlet for utilities such as electric drills, welding equipment etc., shall be provided in all floors of the powerhouse to enable repair and maintenance works to be done locally/ in-situ.

1.8.5 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.

Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

The conducting part in contact with cable shall preferably be tinned or silver plated. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT/ PT circuits	Minimum of two of 2.5 sq. mm copper flexible
All CT/ PT circuits	Minimum of 2 nos. of 6 sq. mm copper flexible

The arrangements shall be made in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

At least 20% spare terminals shall be provided on ach panel / cubicle / box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be minimum clearance of 250 mm between the first / bottom row of terminal block and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

1.8.6 Protection requirement

For short circuit and overload protection of power and control circuits, air circuit breakers, moulded case circuit breakers or MCBs shall be used. Outlets from AC (and DC) distribution panels are protected in their respective panels.

1.8.7 Switches, Lamps & Instruments

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 “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 co-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.

Control and Selector switches

The switches and push buttons shall be provided with ample contact ratings, suitable cam or block arrangements necessary for the control functions on 230 V AC or 220 V DC circuits. The control switches used in mimic diagrams shall be of discrepancy type with built in lamp indication.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Control and Selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front.

Switches with shrouding of live parts and sealing of contacts against dust ingress shall be provided.

Circuit breaker control switches shall have three positions and shall be spring return to "NEUTRAL" from "CLOSE" and "TRIP" positions and shall have pistol grip handles. They shall have at least two (2) contacts closing in close position, and two (2) contacts closing in trip position unless specified otherwise.

Ammeter and voltmeter selector switches shall have four stay out position with adequate number of contacts for three phase 4 wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries. Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

Push buttons

Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 230V AC and 0.5A at 220V DC.

All push buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push buttons shall be provided with integral escutcheon plates marked with its function.

The colour of the button shall be as follows:

Green	:	Breaker Close
Red	:	Breaker Open
Black	:	For overload reset

Indicating and signaling lamps

Each indicating and signaling lamp shall have a removable cap, which can be

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

inscribed with wording and shall not be affected with the heat of the lamp.

Indicating lamps are preferably of LED type & low watt consumption and shall be replaceable from the front of the panel. The indicating and signaling lamps shall be of the same size and type.

Lamps shall be provided with series resistors, preferably built-in the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

Lamps shall have translucent lamp-covers of the following colours, as warranted by the application.

Red	:	ACB's/MCCB's close
Green	:	ACB's/MCCB's open
White	:	Auto trip
Amber	:	For all healthy conditions e.g. control supply
Voilet	:	Circuit breaker spring charged
Blue	:	For all alarm conditions (e.g. overload) Also for "SERVICE" & "TEST" positions indicators

Indication lamps should be located just above the associated push buttons/control switches. All indicating lamps shall be suitable for continuous operation at 90% to 110% of their rated voltage.

HRC Fuses

HRC-Fuses shall have visible operation indicators.

HRC-Fuses shall be mounted on fuses carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

HRC-Fuse rating shall be chosen by the tenderer depending upon the circuit requirements.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Indicating instruments and Meters

Instruments mounted on panels, shall be of the semi flush type back connected, matching pattern, shape, and of approved finish to present neat and fitting appearance consistent with functional requirements Mechanical quantity measuring instruments which are directly mounted on equipment shall have circular dials and shall be properly supported and guarded against accidental injury/breakage. These shall be placed in convenient locations.

The instruments shall accurately measure and indicate the quantity under all conditions of operation with minimum instrument errors. Changes in ambient temperature within the range prevailing at site shall not affect the accuracy

Contact making instruments shall have contacts suitable for 240 V AC or 220 V DC circuits.

The reading scales on the dials shall be in metric units only and range shall be such that the normal operating values of the quantities are indicated in the middle 3rd of the scale. The dials pointer etc. shall be designed to facilitate accurate reading by minimizing parallax and glare from instrument window and by providing clear bold dial markings. The size of dial and length of the scales of the indicating instruments shall be large enough to suit the requirements. The scale plates of panel mounted indicating instruments shall have a permanent white mat finish with black graduations and the pointer shall also be of the black colour. Instruments mounted on panels shall be of flush type and shall be back connected. All instruments on a switchgear panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements.

All instruments shall conform to relevant International or national applicable standards. These shall be subjected to tests prior to dispatch. The instruments shall be shock, vibration and moisture proof. The electrical instruments shall withstand dielectric test of 2000 V RMS to ground for one (1) minute as per standards.

The coils of electrical instruments shall be designed for continuous operation at 110% of the full load current at instrument potential. The coil rating of the measuring instruments shall be coordinated with those of the associated instrument transformers (i.e. CTs, PTs, etc.) by the supplier. The VA burden of the instruments shall be as low as possible. The meters shall be of the first grade in respect of accuracy

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

classification.

Energy meter shall be suitable for 3-phase, 4-wire unbalanced system and shall comply generally with the relevant standard. All instruments shall be tested in accordance with the requirements of relevant standards.

Integrating instruments

The Wh and VArh meters shall be of the semi-flush-mounted type. Each meter shall be connected to terminal blocks suitable for opening and short-circuiting for testing purposes. The meter cases shall be dust-tight and with removable covers. The meters shall be three-phase, three element, equipped with an impulse contact mechanism, potential free for remote metering purposes, and shall be suitable for continuous operation from secondary of potential transformers and from secondary of current transformers, with transformer ratios and connections indicated on the contract drawings.

The meters shall be provided with primary-rated, direct reading registers, with five or more digits and a suitable multiplier. The meters for the outgoing lines shall be of the two-way type and all meters shall have mechanism to prevent negative registration.

The meters shall have built in over-voltage protection and isolation according to IEC Publication 60521. The tolerance ambient temperature range of the meters shall be 0 to 45 degrees C.

The protection class of the Wh meters shall be 0.2 and the VArh meters 0.2 according to IEC Publication 60687.

Measuring converters

The converters shall be suitable for direct connection to the secondary circuits of the potential and current transformers used, or other sensors, each as they apply. The converters shall be static type, having all accessories to provide an output signal of 4-20 mA, filtered DC.

For the measuring converters the following minimum requirements shall be fulfilled:

Current transducers shall be single-phase, of accuracy class 0.5 or better. Voltage transducers shall be single-phase of accuracy class 0.5 or better. W and VAR transducers shall be two elements, three-phase.

Accuracy class of the transducers shall be 0.5 or better.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Measuring transformers

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the distribution board is operating at its rated condition and the outside ambient temperature is 40 deg.C.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.
All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

All VTs shall have readily accessible HRC current limiting fuses on both primary and secondary sides.The class of insulation should be E or better.

The parameter & rating of CTs & PTs are minimum requirement & tentative only. Contactor shall submit the calculations for selection of CT/PT for approval to purchaser.

Potential transformer secondary windings shall be rated 110 / V3 V

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

1.8.8 Nameplates and Labels

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.

The module identification plate shall clearly give the feeder number and feeder designation wherever applicable. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

All name plates shall be of non rusting metal or 3-ply lamicoid with white engraved lettering on black back-ground, inscriptions and lettering sizes shall be as per their standard practice. Suitable plastic sticker labels shall be provided for easy identification of all equipments, located inside the panel/module. These labels shall be positioned so as

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

to be clearly visible and shall give the device number, as mentioned in the module wiring drawings.

1.8.9 Motors

All electric motors for driving various equipments shall conform to relevant standards viz. IEC, BS or IS as applicable.

The motor rating, torque characteristics, speed etc. shall be selected to suit the duty requirements.

Type of starter for motors shall be duly approved by the purchaser during detailed engineering. The detailed design calculation for selection of type of starters is to be submitted for approval. The priority for type of starters shall be in the following order:

1. Variable frequency drive
2. Soft starter
3. Star delta/ auto –transformer
4. Direct on-line starter

The enclosure of each motor shall be of the type best suited for the service conditions of the motor

The motor insulation shall be resistant to moisture, oil or oil vapor and the motors in general shall be so designed as to suit the tropical climate. Varnished cambric or glass insulation class F shall be used for connection from the windings to the terminals.

The terminal box shall be closed conduit box type conveniently located, and shall have means for terminating the external wiring for outdoor use. The motor terminals shall be of the stud type totally enclosed. Eye bolts or lugs shall be provided for lifting.

Space heaters to avoid condensation shall also be provided.

Special type of motors, not adequately covered by these specifications, shall be offered for any special application, but these shall be subject to the approval of purchaser.

1.8.10 Construction power

Contractor shall make arrangement for the construction power for ensuring uninterrupted execution of the works. Suitable no. of DG sets shall be installed at strategic locations for extending uninterrupted power supplies to various sites.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.8.11 Temporary Power and Lighting

The work relating to all temporary lighting and power facilities required for the installation work shall be carried out by the contractor under this contract and shall be included by the bidders in their offer. These temporary installations shall include cables, outlets, and conduits, supports, insulators, fuses, switches and other required materials.

The materials used for temporary facilities shall not be reused in any permanent installation. The work regarding removal of all temporary facilities from the plant premises, after the same have served the purpose, is also covered under the scope of these specifications.

1.8.12 Space heaters

Space heater shall be provided in the Distribution Boards, Control & Protection panels, Motor Control panels etc. The space heaters shall be suitable for continuous operation on 240V AC, 50 HZ single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.

1.8.13 Auxiliary relay, contacts and devices

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a draw out construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-draw out cases.

All AC auxiliary relays shall be suitable for operation with VTs and CTs secondaries.

DC auxiliary relays shall be designed for 220V DC unless otherwise specified and shall operate satisfactorily between 80% and 110% of the rated voltage. Relays shall have adequate thermal capacity for continuous operation in circuits in which they are used.

All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

Suitable number of auxiliary contacts or auxiliary relays shall be provided with each VCB's / ACB's for indication, remote indication, annunciation and automatic

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

changeover and interlocking scheme.

All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flag) for analyzing the cause of operation.

1.9. Mechanical Works

1.9.1 Materials selection

Materials shall be new and of high-grade quality, suitable for the purpose, free from defects and imperfections, and of the classifications and grade listed herein, or their equivalents subject to acceptance by the Owner. Material specifications, including grade or class shall be shown on the appropriate Contractor's detail drawings submitted for review. Materials not listed herein but equivalent in their basic properties may be used subject to the Owner's review of their acceptability.

S. No.	Material	Specification
1	Carbon-steel castings	DIN-1681, Steel castings for general use: quality specifications, grade GS-45 / GS-60 ASTM A27 Grade 65-35 GS-45/ GS-60
2	Iron castings	DIN-1691, Gray iron castings for general use: quality specifications, grade GG-22 and GG-26.
3	Corrosion-resistant steel castings	DIN-17445, Stainless quality specifications type G-X 8 Cr Ni 13 (1.4008) and G-X 6 Cr Ni 18 9 (1.4308), For runners EN Grade:X4 CrNiMo 16-5-1 (Number 1.4418), EN Grade GX4 CrNIMo 16-5-1 (Number 1.4405)
4	Corrosion-resistant steel plate, bars, pipes	DIN-17440, Stainless steel: quality specifications: X 2 Cr Ni Mo 1810(1.4404) X2 Cr Ni Ti 1810 (1.4541) X10 Cr Ni Mo Ti 1810(1.4571) X22 Cr Ni 17 (1. 4057) DIN 2462 Seamless stainless steel pipes.
5	Hardened	DIN-17440, Stainless steel: quality

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	corrosion resistant steel	specifications X 10 Cr 13 (1.4006) hardened condition.
6	Carbon steel forging (turbine/ generator shaft, important parts)	DIN-17200, Quenched and tempered steels, Ck 35/Ck 45 ASTM A 668 Grade D.
7	Carbon steel forging (pipe flanges, fittings etc.)	DIN-17100, Steels for general structural purposes: quality specifications grade RSt 37-2 / St 52-3.
8	Carbon steel plates (for low-stressed parts and piping)	DIN-17100, Steels for general structural purposes: quality specifications, grade St 37-2 (1.0116). ASTM A 283 Grade B.
9	Carbon steel plates (for important stress carrying parts)	DIN-17100, Steels for general structural purposes: quality specifications, grade ST52-3 (1.0841), normalized. ASTM A 287 Grade B.
10	Intermediate and high strength steels (for important stress carrying parts and structures under hydraulic pressure)	DIN-17102, weldable fine grain steels, normalized, grades TTStE. ASTM 514.
11	Bronze casting	DIN-1705, Bronze castings: quality specifications.
12	Bronze (for bolting)	DIN-17672, Rod, bar of wrought copper and copper alloys: mech. Properties non-leaded copper-zinc alloys with min. U.T.S of 370 N/mm^2
13	Copper Tube	DIN-1754, Tube of copper: seamless

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

		drawn, material type SFCu F30 according to DIN-17671.
14	Steel pipes	DIN-2448, Seamless steel tubes: dimensions and weights. DIN-2458, Welded steel tubes dimensions and weights. ASTM A53, API 5L , ASTM A 106
15	Steel pipe flanges and flanged fittings	Applicable DIN-standards for weld neck and slip-on flanges.
16	Bolts and fasteners	DIN-13, ISO metric screw threads from 1 to 300 mm diameter: selection for diameters and pitches. DIN-267, Fasteners and similar parts: technical specifications complete. Other applicable DIN standards.

All materials or parts used in the equipment shall be tested in conformity with the standards specified herein or other applicable standards approved by the Owner.

Certified Material Test Report for the materials of major/important components and/or materials for special application shall be furnished to the Owner as soon as possible after the tests are performed. Each test certificate shall identify the components for which the materials are used and shall contain all information necessary to verify compliance with the Contract Documents.

1.9.2 Welding & NDT

1.9.2.1 Preparation of base material

Members to be joined by welding may be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. Edges shall be shaped according to ASME requirements. Design of welded joints and selection of weld filler metal shall be in accordance with approved standards and shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces to be welded shall be sound metal free of visible defects such as laminations or defects caused by cutting operation at least 30 mm back from the edge of the weld, and free from rust, oil, grease, and other foreign matter.

1.9.2.2 WPS & WPQR

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The establishment of welding procedures, welder's qualifications shall conform to the requirements of the ASME Boiler and Pressure Vessel Code Section VIII and IX. The approved copy of the WPS & WPQR in accordance with the ASME requirements shall be submitted to the purchaser for review and record..

1.9.2.3 Welded construction and stress relieving

Weld-fabricated pressure-containing parts shall be designed, fabricated, stress relieved inspected and tested, unless otherwise specified, in accordance with ASME-VIII.

1.9.2.4 Non-Destructive Testing

Examination of Welds

Combination of NDT techniques i.e RT, UT, MPI, DPT shall be used to ensure the soundness of the weldments depending upon the requirement and geometry of the welds in accordance with the provisions of the ASME. The acceptance criteria for various NDT, NDT personnel shall be as per ASME-V/VIII/IX.

The Contractor's Drawings shall indicate the type and extent of non-destructive examination as it applies to each component or weld. Distinct notations shall be used on the drawings to differentiate shop and site welding.

Examination of Casting

All cast material including Turbine Runner etc. shall be given complete non-destructive examination including radiographic examination of the most critical areas. The Contractor shall submit Quality Sheets (Specification for inspection of steel casting for hydraulic machines), with his recommendation and specify special precautions to be taken of the casting of the turbine runner and other important casting components. The Quality Sheets submitted shall define the area and extent of the various non-destructive examinations to be performed on castings. The examination of castings shall be in accordance with the provisions of CCH-70.

Examination of Forging

Shafts, stems and coupling bolts made of forgings shall be given complete ultrasonic examination and other applicable non-destructive test, to determine that they are sound. Non-destructive examination of other forgings shall be in accordance with accepted good practice to assure their soundness. The structure of forgings shall be homogeneous and free from excessive non-metallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be a cause for its rejection.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.9.2.5 Field welding

Filler material required for field-welded joints shall be furnished by the Contractor. The Contractor shall perform all welding work at site in accordance with the applicable WPS. Only qualified welders shall be used for undertaking welding as per the applicable WPS.NDT shall be performed as per the approved drawings.

Preparation for field welding

All cutting, chamfering, and other shaping of metals necessary for the field connection shall be done as far as possible in the shop. Adequate temporary bolted field connections shall be provided to hold the assemblies rigidly and in proper alignment during shop and field assembly.

To ensure proper alignment during field erection, a minimum of two dowels shall be provided for each field connection between subassemblies. The holes shall be drilled and the dowels fitted at shop assembly after the subassemblies have been satisfactorily aligned. All stipulations for welding, structural work and other, shall be applied to fieldwork as well as to shop work, except where otherwise stated.

1.9.3 Painting

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 required number of coats. The Contractor shall perform all painting work in the shop, before shipment, followed by a final coat of paint at site after installation as per the standard procedure.

All materials, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers.

Colour schedule of equipment supplied shall be finalized during detailed design stage.

1.9.4 Galvanization

All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process commences. All galvanizing shall be done by the hot dip process with smelter, not less than ninety eight percent (98%) of which must be pure zinc. No alternative process shall be used without the approval of the purchaser. No components shall be galvanized which are likely to come into subsequent contact with oil. Bolts shall be completely galvanized

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

including the threads, but the threads shall be left uncoated in the case of nuts. The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. In the case of component parts the zinc coating shall weigh not less than 0.6 kg/m2 over the area covered and be not less than 0.09mm in thickness. All galvanizing shall comply with the requirements of the relevant ASTM standards/Indian Standards. All galvanized parts shall be protected from injury to the zinc coating due to differential aeration and abrasion during the period of transit, storage and erection. Damaged areas of the coating shall be touched up with an approved zinc dust paint or other approved flake metallic compound.

1.9.5 Pumps

All pumps forming part of the generating units and other plant and equipment shall be of high performance requisite type (viz. centrifugal, rotary etc.) and rating, of reputed make, and shall be directly coupled to their driving motors. The pumps shall be of self priming type and with proper sealing systems and protection.

The materials of construction of pumps in general shall suit the service conditions. The materials of construction of the pumps handling water, such as drainage & dewatering pumps, turbine top cover drainage pumps etc. shall be resistant to abrasive effects of silt in such water. The pumps shall operate quietly without undue noise and vibration in their full operating range of head and flow. They shall be easy to maintain.

1.9.6 Embedded parts, Anchor Bolts and Fasteners

All embedded anchor bolts, rods, pipes, welding plates and support plates shall be provided by contractor. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is embedded. 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.

1.9.7 Pipes, valves, Bends, Flanges

Connections to penstock shall be kept to the minimum. All penstock and tail water connections shall be double valve. The penstock and tail water connections shall be embedded wherever possible. The material used for pipe connections to the penstock and draft tube shall have proven ductility with Charpy impact values of not less than 35 J at – 20 ºC.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Piping, tubing and pipeline materials and equipment forming part of the generating units & other plant and equipment shall be of appropriate materials, size and type to suit the function and shall conform to the relevant & applicable standards. The piping shall be complete with requisite valves, automatic valves, drain plugs or cocks, test plugs or cocks, sight flow indicators, flow meters, flow relays, thermometers, pressure switches and other necessary instrumentation and devices to provide desired function and operation with ease and flexibility and easy maintenance. Valves to be kept normally locked in open or closed position shall be provided with suitable locking arrangement.

Piping, tubing and pipeline materials and equipment forming part of the generating units & other plant and equipment shall be of appropriate materials, size and type to suit the function and shall conform to the relevant & applicable standards. The piping shall be complete with requisite valves, automatic valves, drain plugs or cocks, test plugs or cocks, sight flow indicators, flow meters, flow relays, thermometers, pressure switches and other necessary instrumentation and devices to provide desired function and operation with ease and flexibility and easy maintenance. Valves to be kept normally locked in open or closed position shall be provided with suitable locking arrangement wherever necessary.

Suitable support system for the piping and valves comprising hangers, brackets, hooks, pedestal etc. shall be designed and provided.

Pipelines may undergo expansion or contraction under service conditions and adequate allowance shall be made for the same.
Spare branch connections provided for any future extension of piping shall be provided with isolating valves whose open ends shall be protected with blank flanges or caps as the case may be. Dismantling pieces with flanges, or unions shall be provided for ease of disconnection of piping for servicing.

Connections with equipment or apparatus may be by flexible pipe to enable easy connection and disconnection.

All items of pipe lines shall be thoroughly cleaned individually before installation and after erection, in stages, on completion, using proper method. It shall be ensured that they are perfectly clean inside before putting into use.

The layout shall be such that valves, gauges/indicating instruments, are conveniently located to enable easy access for operation and reading. Piping shall be installed in trenches/ducts/openings along floors, walls or ceiling as necessary. The layout shall be such as would not interfere with movement of Operation and Maintenance (O&M) personnel.

Lagging of piping runs, wherever necessary e.g. Cooling Water System, Drainage Dewatering System, Flood Protection System etc. shall be provided.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The support system shall be rigid enough to prevent piping vibration when in operation.

For ready identification of different piping system functions, each piping system shall be painted near all operating points and also on each separate section, with two bands of colour, the wide band twice the width of the narrow one. An arrow showing the direction of flow shall also be marked. Generally, the narrow band shall be in the direction of flow. The colour coding for the ground colour, the wide band and the narrow band on different pipes shall be as recommended in Indian or International standards.

All operating valves on a piping shall be painted with the colour mentioned above. Each valve shall have, suitably fitted to it, a name plate indicating the function of the valve.

The gaskets shall be of requisite material and thickness to suit service conditions.

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

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

Rust Prevention and Protection during Transit:-

Bright steel parts including all machined surfaces shall be given a thick coat of tar or tallow or any other approved rust resisting paint in plain colour to prevent rusting during shipment and transport.

1.10. Civil Works

Civil foundations for equipment of the generating units and other plant and equipment will be prepared by the Purchaser in accordance with the basic design data to be supplied by the Contractor.

The Contractor shall provide design for foundations and install the concrete inserts/embedment; support steels and/or components for foundation /supports purpose, shall do any chipping / leveling works, denting / painting etc.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.13.7 Recommended Spares

In addition to the mandatory spare parts, the Contractor shall also provide a list of recommended spares for five (5) years of normal operation of the plant and indicate the list and total prices in relevant schedule. The list shall take into consideration the mandatory spares specified and should be independent of the list of the mandatory spares. The purchaser reserves the right to buy any or all of the recommended spares within warranty period.

Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid upto execution of the contract. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the purchaser, if required.

1.14 Erection, Testing, Commissioning and performance of Guarantee Tests

1.14.1 Testing and inspection

Materials used for construction of major & important sub-assemblies shall be thoroughly shop tested and inspected by the Contractor at his own expense prior to dispatch. Shop test shall comprise of routine test & type tests.

The shop tests and inspections shall be as spelt out in individual equipment specifications as dealt in succeeding sections but shall not be limited to the same. Any other tests and inspection not specifically listed but are otherwise considered essential and advisable shall also be conducted.

The Bidders shall furnish schedule of the shop tests and inspections on materials and equipment.

Important tests/inspections shall be subject to witness by the purchaser for which the Contractor shall give sufficient advance notice. In case purchaser is unable to witness shop tests/inspections, the Contractor shall be so intimated and the tests/inspections may then be carried out in the absence of the Purchaser.

Equipment on which tests and inspections have been duly witnessed and approved by the Purchaser may be dispatched by the Contractor.

Equipment on which tests and inspections have not been witnessed by the purchaser shall be dispatched only after the shop tests and inspection Certificates have been approved by the Purchaser.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Pressure Tests

Unless specifically mentioned otherwise in the Contract Documents, equipment, vessels and tanks under internal pressure during service shall be subject to hydrostatic pressure testing. The test pressure shall be 1.5 times the maximum design pressure of the respective equipment, vessel or tank.

The test pressure shall be applied for appropriate duration according to standards without showing leaks or drop in pressure.

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.

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.

1.14.2 Erection, commissioning & field tests

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The Contractor shall submit the necessary data/information, layout and foundation/support drawings well in advance.

The Contractor shall provide and install the concrete inserts/embedment, support steels and/or components for foundation/supports purpose as per approved erection drawings and coordinate the activities with civil contractors to keep his activities in synchronism with civil work. All installation for foundation shall be verified and accepted by the Engineer.

The Contractor shall use anchor fasteners for installation of piping, fixtures, mountings, conduits, cabling, panels etc. Minor Chipping of concrete is permitted. However, taking support from reinforcement bars shall not be allowed.

1.14.3 Installation procedure

The Contractor shall submit six copies of all detailed programs and the procedures to be adopted for erection / installation, testing and commissioning well in advance, before start of erection activities/ installation.

The installation procedure shall also have a section "site quality assurance plan" containing erection data sheets / site protocols for various components. These sheets should specify site measurements/ inspections required to be made for ensuring proper installation.

1.14.4 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 Engineer 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 by either 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 and appropriate intermediate locations as per Standard.

1.14.5 Field inspection

The Contractor shall permit Engineer to perform inspections of the assembly which will include a complete verification of the assembly of all parts as to their levels, clearances, pertinent fits, alignments and quality of workmanship. The field supervisor of the Contractor shall provide Engineer with three (3) copies of all the clearances, tolerances and data of all pertinent fits, alignments and levels, so that the latter may repeat the Contractor's measurement, if desired.

Unless otherwise specified, any rejection based on the inspection will be reported to

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Contractor within fifteen (15) days.

1.14.6 Field tests

All field tests including tests during installation, pre-commissioning, commissioning, performance and field acceptance tests shall be conducted by the Contractor, in the presence of representative of the Employer. Procedure to be adopted for conducting these tests shall be submitted well in advance, before start of relevant testing, for approval of the Employer.

The equipment / system shall be deemed to be commissioned and ready for trial run only after successful operation for a test service period specified in sub clause "Performance Testing". In the event of any failure this period shall be repeated for any number of times till the successful operation as described above is achieved.

All test equipment and instruments shall be furnished by the Contractor and will remain the Contractor's property after the fulfillment of all field tests.

Any defects or leaks disclosed in the tests shall be duly mended/ repaired to meet the desired function and retested

All necessary materials and labour for performing all the above tests shall be provided by the Contractor.

The Contractor shall prepare written test certificates in a form agreed upon by the Contractor and Employer of all tests results and hand them over to the Employer in due time.

The design, location and approval tests of anchoring rings for the fixing of lifting apparatus necessary for assembly and dismantling of equipment and plant accessories shall be the responsibility of the Contractor.

1.14.7 Taking over of facilities

"Taking over" means that the Facilities (or a specific part thereof where specified) have been completed operationally and structurally and put in a tight and clean condition, and that all work in respect of pre-commissioning of the Facilities or such specific part thereof has been completed and commissioning has been attained as per Technical Specifications. The contractor shall make formal request for taking over the facility to the EIC.

1.14.8 Operation acceptance

The operational acceptance by the Employer of the Facilities (or any part of the Facilities where the Contract provides for acceptance of the Facilities in parts), which certifies the Contractor's fulfillment of the Contract in respect of Functional Guarantees of the

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Facilities (or the relevant part thereof) in accordance with the provisions of GCC / SCC.

1.15. Consumables, oils and Lubricant

The Contractor shall deliver to the Owner all equipment complete with initial fill of fluids, grease or lubricants, transformer oil, Nitrogen, SF6 gas and other used gases in non returnable drums / containers and replace any quantity used up or lost during installation and testing.

The oil used for the lubrication and oil pressure systems for the turbine, governor, shutoff valve and generator shall be preferably of the same type.

Supply

The Contractor shall furnish the following:

(i) All oil for initial filling of all equipment supplied, plus additional oil equivalent to the first filling requirement of one unit.

(ii) Grease if required for initial filling of all of the equipment, plus 10% additional.

(iii) Gases for initial filling of all equipment supplied, plus 10 % additional quantity.

(iv) Flushing fluids to flush and clean all systems.

1.16. Type tests:

Type tests have been divided into following two categories:

(a) Category-I

The contractor shall carry out type tests listed under Category -I for the respective equipment. The charges for each of these type tests shall be indicated separatelyin the respective price schedules and the same shall be considered for the evaluation of the bids. The owner reserves the right to waive conducting of any or all of the specified type tests on submission of type test certificates from Govt. approved labs/ accredited laboratories conducted on similar equipment during last five (5) years from the date of bid opening, in which case the type test charges shall not be payable for the type tests which are waived. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract.

(b) Category-II

The contractor shall only submit the certificates from Govt. approved labs/ accredited laboratories of the type tests listed under Category -II for the respective equipment which

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

should have been carried out within last five (5) years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct the test without any financial implication to purchaser.

1.17. Interface Management

The Bidder shall ensure the functional and physical compatibility of supply at each physical interface among various Sub-bidders/ Manufacturers/ Vendors / other third party interface such as Civil, Hydro Mechanical etc. in order to ensure efficient, reliable and safe operation of the whole system/ Scheme.

- List of critical Interfaces:

1. Turbine shaft & Generator DE shaft
2. Bus Duct & Generator Phase Terminals
3. Bus Duct & Generator Transformer
4. GT & GIS
5. ACSR conductor & GIS SF6 to Air Bushing
6. MIV Dismantling Pipe to Spiral Inlet
7. MIV Inlet Pipe to Penstock
8. PPV inlet/outlet pipes to Penstock
9. Pot Head Yard Gantry to incoming/outgoing towers

The Bidder shall ensure co-ordination among various sub-bidders, to verify the continuity and the coherence between themselves. The Bidder shall also resolve all interfacing requirements among various sub-bidders for execution of the work as per scope of contract. Engineer-in-Charge shall provide necessary help for such co-ordinations with different sub-bidders (if chosen by Owner including penstock contractor).

The contractor shall provide compliance certification of interface management at design / engineering level of the concerned interface unit while submitting drawing / document of above interface activities.

1.18. Functional Guarantee Schedule

The bidder has to provide the functional guaranteed value for the following equipments as per Annexure - A of GTS:-

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1. Turbine
2. Generator
3. Generator Transformer
4. Shunt Reactor
5. IPBD
6. PPV
7. GIS
8. XLPE

Annexure –A contains various columns - guaranteed values which need to be achieved, bid equalization mechanism, penalty clause in case of non achieved guaranteed values, rejection limits, location to demonstrate guarantee & rectification to meet guarantee.

1.19. Submission of Drawings, Documents, Manual, software, Calculations, Safety Margin Details etc.

All drawings and documents shall be submitted to purchaser in hard form as well as in editable soft form. Bidder shall submit Ten (10) number hard copies of the documents & drawings to purchaser for reference / review / approval. A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand to the purchaser.

1.19.1 Design memorandum

The Bidder shall prepare and submit to purchaser a "Design Memorandum" of the proposed equipment/ system for each section fulfilling the contract specification/ requirement for approval prior to submission of drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement/ layout etc.

1.19.2 Plant Designation System

The Bidder shall submit the plant designation system such as KKS, RDS-PP etc. to be followed within six (6) months from the date of Letter of award.

1.19.3 Drawings

Loading drawings

For all larger pieces of Works which, due to their dimensions and/or weight and transport limitations, will require special means for their transportation, the Contractor shall submit binding loading drawings indicating dimensions, weights, etc., of the respective pieces of Works and the necessary trailer for its transportation to the site.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Foundation drawings

If a piece of works requires its own foundation or needs a special area for installation, the contractor shall submit drawings indicating all pertinent dimensions, static and dynamic loads, etc. They shall include all essential details required for proper design and construction of the foundations and/or buildings.

In addition, they shall include openings, sleeves, slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

If conduits are to be installed in the foundations, the relevant information such as diameter, length, and purpose shall be indicated on the drawings.

Arrangement drawings

All arrangement drawings shall be drawn to scale. The General Arrangement Drawings shall show the physical arrangement of Works (constructions, machines, complete switchgears, control panels, instrument cubicles, etc.), civil constructions (buildings, rooms, foundations, ducts, etc.) and reserved areas (for pipes, cables, lines, etc.) in relation to each other and to agreed co-ordinates and boundaries. Such drawings shall be prepared for the whole plot, for separate plots and for each building (building, hall, room, ducts and trenches, etc.).

Outline drawings

The Outline Drawing shall show all elements and the main dimensions of individual components where necessary in plan view, cross-section, side and top views. If reasonably possible such dimensions can be shown on Arrangement Drawings.

Design drawings

The Design Drawings shall include the shop drawings, assembly drawings, erection drawings, piping diagrams and piping arrangement drawings, etc., showing the dimensions, design and data of all constructions, apparatus and Works to be furnished under this Contract. The drawings shall - where applicable - substantially conform to the Contract Drawings and shall show:

- 3-D Assembly drawings for major components in hard and soft form.
- Details of manufacturing and treatment of major single work pieces specially manufactured for this Contract
- Assembly of the Works in plan and elevation with main dimensions

- Sub-assembly of the principal components of the Works with overall dimensions, adjustment and clearance tolerances, numbers of corresponding detail drawings
- Sub-assemblies in which the Contractor proposes to ship the Works
- All necessary details of the parts connecting to the Works supplied by others
- Location and sizes of auxiliary connections for oil, grease, water, air, electrical power etc.
- Location and size of the instruments and accessories provided
- Methods of lubrication and sealing
- Instructions for heat treatment, pressure tests, surface preparation and anti-corrosive protection
- Full details of parts for which adjustment is provided or which are subject to wear
- Method and sequence of installation, field joints, erection and lifting devices, jacks, grout plugs, anchoring details, etc., if not shown on foundation drawings.

Installation drawings

The construction, mechanical, electrical and I & C Installation Drawings shall provide detailed information on the disposition of the various items of a system (e.g. lighting fixtures, socket outlets, connection boxes, transmitters, actuators, loudspeakers, telephones, pipes, valves, pumps, compressors, etc.) and of the piping and wiring respectively included in the installation or assembly. They shall be based on dimension drawings of cubicles, rooms, buildings or areas containing the Works.

1.19.4 Diagrams

Single-line diagrams

This is a simplified diagram of the essential electrical Works and their interconnections. Each circuit shall be represented by a single line only. It shall contain all required technical information of the Works represented, e.g. voltage, current, capacity, short-circuit level, ratios, voltage variations, positive and zero sequence impedances, measuring transformer and protection relay indices, interlocking, kind of switch drive, code designation, etc. as applicable.

Circuit diagrams

The Circuit Diagrams shall show the power circuits in all the phases with the main apparatus as well as the pilot circuits (measuring and control circuits). It shall show in full the functioning of part or all installations, Works or circuits with all required technical

Block diagrams

The Block Diagrams shall be used to show in a simplified manner the main inter-relationships between the elements of a system by means of symbols, block symbols and pictures without necessarily showing all the connections. The symbols used for the individual kinds of components, e.g. servomotors, computing modules, etc., shall clearly be explained on the diagram or on an attached legend.

Logic diagrams

The Logic or Functional Diagrams shall be used for representation of logic and sequence controls and interlocking by showing only binary logic elements and their effect on the various process equipment disregarding their electrical realisation. Logic function elements (AND, OR, NOR, NAND, STORAGE, etc.) shall be used for processing and combining binary signals.

Terminal diagrams

Such diagrams shall be prepared for any type of terminal box, marshalling rack, control cubicle, switchboard, etc., and shall show the terminals (properly numbered) and the internal and/or external conductors (wires or cables) connected to them.

The terminal diagram of each individual switchboard, terminal box, panel, etc., shall contain, but not be limited to the following information:

Protection co-ordination diagrams

These diagrams shall show in a graphical manner separately for each power supply circuit:

- A simplified single-line diagram of the circuit with technical data of all instrument transformers and relays
- Co-ordinated tripping curves of related protection devices
- Setting of the protection devices.

Emergency shutdown diagram

This diagram shall show the sequential steps and interdependencies during emergency closure.

Flow Charts

Flow charts shall be used for representing sequence of events for start / stop / shut down of the machine including associated equipment and auxiliaries.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.19.5 Manuals

The following manuals covering all equipments of EM works shall be supplied as per the time schedule in both editable soft and hard form:-

Sr. No.	Manual Description	Time Schedule
1.	Storage and preservation manual	Before start of dispatch
2.	Safety manual	Before start of DT Erection of 1st unit
3.	Erection Manual	Before start of DT Erection of 1st unit
4.	Testing and commissioning manual	Before start of Testing & Commissioning of 1st unit
5.	Operation manual	Before Commissioning of 1st unit
6.	Maintenance manual	After commissioning of all units
7.	Long term storage manual for Generator Transformer	After commissioning of all units
8.	Long term storage manual for boxed up component / equipment.	After commissioning of all units
9.	Repair process / procedure manual for equipment / system	After commissioning of all units

1.19.5.A As built drawing to be provided incorporating changes made during erection, testing and commissioning.

1.19.6 Drawing & Document Submission Schedule

Drawings & documents submission schedule of the EM package with the categorization (i.e. Approval / reference) & tentative submission date shall be submitted to purchaser for approval within six (6) months from the date of Letter of award of contract. The list of drawings in the proposed schedule shall not be limited to the drawings/documents/ manual etc. covered under clause 1.19, the list as per Annexure – D of this section & the list covered under head "Drawings, Documents & Design Calculation" of each section.

Preliminary list of drawings under various categories have been prepared and appended at Annexure – D.

1.20 Quality Assurance Requirement for Electro-Mechanical Package

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.20.1 QUALITY ASSURANCE PROGRAMME

The Bidder shall follow Quality Assurance Programme to ensure that the equipment and services under the scope of contract whether manufactured or performed at the Bidder's works or at his sub-vendor's premises or at the SAPDC's site or at any other place of work are in accordance with the technical specifications. Such programme shall be outlined by the Bidder and be submitted along with the bid. The QA programme shall be generally in line with IS/ISO- 9001 and generally cover the following:

- ORGANISATION STRUCTURE FOR THE MANAGEMENT AND IMPLEMENTATION OF THE PROPOSED QUALITY ASSURANCE PROGRAMME
- QUALITY SYSTEM MANUAL
- DESIGN CONTROL SYSTEMS
- DOCUMENTATION AND DATA CONTROL SYSTEMS
- QUALIFICATION/EXPERIENCE OF BIDDER'S KEY PERSONNEL.
- PROCEDURE FOR PURCHASE OF MATERIAL, PARTS, COMPONENTS AND SELECTION OF SUB-VENDOR'S SERVICES INCLUDING VENDOR ANALYSIS, SOURCE INSPECTION, INCOMING RAW-MATERIAL INSPECTION, VERIFICATION OF MATERIALS PURCHASED, ETC.
- SYSTEM FOR SHOP MANUFACTURING AND SITE ERECTION CONTROLS INCLUDING PROCESS, FABRICATION AND ASSEMBLY.
- CONTROL OF NON-CONFORMING ITEMS AND SYSTEM FOR CORRECTIVE ACTIONS AND RESOLUTION OF DEVIATIONS.
- CONTROL OF CALIBRATION AND TESTING OF MEASURING / TESTING EQUIPMENT.
- SYSTEM FOR QUALITY AUDITS.
- SYSTEM FOR IDENTIFICATION AND APPRAISAL OF INSPECTION STATUS.
- SYSTEM FOR AUTHORISING RELEASE OF MANUFACTURED PRODUCT TO THE PURCHASER.
- SYSTEM FOR TRANSPORTATION /DELIVERY, HANDLING, STORAGE AND PRESERVATION.
- SYSTEM FOR MAINTENANCE OF RECORDS.

1.20.2 GENERAL REQUIREMENTS - QUALITY ASSURANCE

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.20.2.1 All materials, components and equipment covered under scope and its technical specifications shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme agreed mutually.

1.20.2.2 Minimum Quality Assurance Test Requirement (QATR) to be followed during Manufacturing and Field erection indicating requirement of various tests / inspections, on major equipment / items, to be carried out as stipulated in technical specification and standards mentioned therein, are attached hereto and are part of bidding documents. Clarification, if any, on these quality assurance test requirement, raised by bidder shall be discussed and resolved during pre-bid meeting.

1.20.2.3 After the award of contract, the contractor shall submit the detailed Manufacturing & Field Quality Assurance Plans for complete equipment / material during detailed engineering in the format attached hereto (format of quality plan F-060-02 issue 2.0 rev. 01, Total 1 Page) for approval and acceptance by SAPDC/Consultant in line with technical specification, Quality Assurance – General & Test Requirements and detailed engineering.

1.20.2.4 Manufacturing Quality Assurance Plans shall detail out for all the components and equipment & various tests/inspection, to be carried out in conformity with relevant latest IEC/IS/ISO etc, quality practices and procedures to be followed by Contractor's / Sub-vendor's Quality Control Organization, the relevant reference documents, standards and acceptance norms etc. during all stages of material procurement, manufacture, assembly and final testing / factory acceptance tests.

1.20.2.5 The Field Quality Assurance Plans shall detail out the various tests/inspection to be carried out in conformity with relevant latest IEC/IS/ISO, quality practices and procedures etc. to be followed by the contractor's / sub-contractor's site Quality Control Organisation during various stages of site activities from receipt of material/equipment at site till final commissioning/ acceptance/handover.

1.20.2.6 All major items/ equipment/ components to be manufactured in house as well as procured from sub-vendors (Bought out Items, BOI) to be listed in the bid. Bidder shall submit Quality Assurance Plan submission schedule in the bid for above listed items in attached Format (duly filled in the format F-060-05 Issue 2.0 Rev. 00, Total 1 Page) in line with L2 Schedule.

1.20.2.7 For components / equipment / Bought out Items procured by the contractor for the purpose of the contract, the Contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the sub-vendors.

The quality plans called for from the sub-vendors shall detail out, during the various stages of manufacture and installation, the quality practices and procedures followed by the sub-vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful sub-vendors shall be finalized with the SAPDC/Consultant in line with requirement mentioned at clause no. 1.20.2.3 above and such approved Quality Plans shall form a part of the purchase order/contract between the contractor and his sub-vendor.

Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications and other related documents such as data sheet, drawings, quality plans and delivery conditions shall be furnished to the SAPDC/Consultant by contractor along with a report of the Purchase Orders placed, on the monthly basis, so far for the contract.

1.20.2.8 The Quality Plans shall be submitted on electronic media e.g. CD or E-mail in addition to hard copy, for review and approval of SAPDC/Consultant. After approval, the same shall be submitted in compiled form on CD-ROM by contractor.

1.20.2.9 For all spares, replacement items and additional similar items, the quality requirements/Quality Plans as agreed for the main equipment supply shall be applicable.

1.20.2.10 All material of construction shall be as per technical specification / approved drawings / GTP.

1.20.2.11 Contractor's Plant internal standards must be traceable to acceptable International / National standards & salient points of difference (if any) shall be clearly stated with submission of plant standards. The contractor shall furnish copies of reference documents, plant standards, acceptance norms, test and inspection procedure etc. as referred in Quality Plans along with Quality Plan to SAPDC/Consultant. These Quality Plans and reference documents/standards etc. will be subject to approval of SAPDC without which manufacturer shall not proceed. These documents shall form a part of the contract.

Tests on components and sub-assemblies shall be carried out at various stages of manufacturing, till the product undergoes the final tests in conformity with the relevant standards.

1.20.2.12 The Customer Hold Points (CHPs), identified in approved quality plan, i.e. testing checks which shall be carried out in the presence of the SAPDC, beyond which the work will not proceed without written consent of SAPDC's authorized representative.

1.20.2.13 The contractor / sub-vendor shall carry out routine test on 100% items at his works. The quantum of check / test for routine and acceptance test by SAPDC/Consultant shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned, quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering.

The quantum of check when specified in percentage (%) / sampling basis shall be treated as per lot per sub-vendor. When the quantum of check is indicated to in whole no., then same quantum of check shall be applicable to each sub-vendor supplying the same equipment.

1.20.2.14 For sub-vendors identified during pre-award stage for submission of vendor details / credentials (category "DR"), contractor shall submit documents in format F-060-01 after placement of award in the manner as specified in Clause no. 1.20.2.17 prior to any procurement and within a month after placement of award or a period as agreed at the time of pre-award discussions.

The proposed sub-vendors should be registered vendors of the bidder and must have proven experience for successful operation for similar equipment / items / processes as mentioned elsewhere in technical specification.

1.20.2.15 Before assigning any portion of work to the sub-vendor, other than one specified and duly accepted in the contract, the contractor will take prior approval of SAPDC.

1.20.2.16 While sub-contracting any portion of work, it shall be mandatory to include these quality assurance – general & test requirements along with vendor qualification criteria, if indicated elsewhere in the technical specification, as a part of their bidding document.

1.20.2.17 Normally no request for change of sub-vendors or inclusion shall be entertained by SAPDC. But in exceptional circumstances, if the request for change of sub-vendors or inclusion is found reasonable and justified, then the same shall be entertained and the

decision of SAPDC in this respect shall be final and binding. The time consumed for the change / inclusion of sub-vendors shall not be excluded from the stipulated time of the completion of the contract. This change shall not relieve the contractor from the responsibility to complete the work within stipulated time in any manner.

1.20.2.18 The contractor's proposal shall include sub-vendor's facilities established at the respective works, the process capability, process stabilization, Q.C. system followed, experience list etc. along with his own technical evaluation of sub-vendor. (Format F-060-01 issue 2.0 rev. 01, Supplier / Sub-vendor Assessment Sheet, Total 14 pages). However, whenever felt necessary, sub-vendor assessment will also be carried out by SAPDC/Consultant in accordance with the above procedure and by factory visits; for existing/proposed vendors/sub-vendors. This approval shall not relieve the contractor from any obligation, duty or responsibility under the contract & SAPDC shall not be responsible for any complications arising between the contractor and his sub-contractor(s) / sub-vendor (s) and / or any other liabilities.

1.20.2.19 SAPDC/Consultant reserves the right to carry out quality audit and quality surveillance of the system and procedures of the contractor / or their sub-vendor. The contractor shall provide all necessary assistance to enable SAPDC/Consultant to carry out such details & surveillance including Quality Manuals, if required by SAPDC/Consultant.

1.20.2.20 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirement of ASME section-VIII/IX or other International equivalent standard acceptable to SAPDC/Consultant. All welding/brazing procedures shall be submitted to SAPDC/Consultant for review / verification prior to carrying out the welding/brazing. However, wherever required by the SAPDC/Consultant, tests shall be conducted in presence of SAPDC's authorized representative.

1.20.2.21 All Brazers, Welders and welding operators employed on any part of the contract either in Contractor/his sub-vendor's works or at site or elsewhere shall be qualified as per ASME section-VIII/IX or other equivalent International Standards acceptable to SAPDC/Consultant.

1.20.2.22 Unless otherwise proven and specifically agreed with SAPDC/Consultant, welding of dissimilar material and high alloy materials shall be carried out at shop only.

1.20.2.23 All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American or Indian Society of non-destructive examination). NDT

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

shall be recorded in a report, which include detail of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

1.20.2.24 All material used for equipment manufacture including castings and forgings, etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

1.20.2.25 Contractor shall submit Field Welding Schedule for field welding activities like field welding location, numbers, welding procedure to be used, requirements, codes and NDT requirement along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures, etc. to SAPDC/Consultant for review at least ninety days before schedule start of erection work at site.

1.20.2.26 Any other statutory requirements as applicable for the equipment / systems shall also be complied with.

1.20.2.27 The inspection calls (duly filled in the format F-060-06 Issue 2.0 Rev. 00, total 1 Page) shall be placed at least 06 weeks in advance for overseas inspections excluding India and 15 days in advance for inspections within India and Nepal.

Before submitting the inspection call to SAPDC for witnessing the Customer Hold Points (CHP's) and/or requesting SAPDC for issuance of Material Dispatch Clearance Certificate (MDCC) based on Test Certificate (TC) review / Certificate of Conformance (COC), the contractor shall ensure that all Drawings / documents / GTP / technical data sheet, relevant to respective CHP / MDCC requirement, has been duly approved / accepted / noted by SAPDC.

1.20.2.28 Contractor shall ensure readiness of offered equipment by all means, before raising such call to SAPDC to attend CHP inspections. In case, SAPDC engineer (s) on reaching at a place of inspection found that material is not ready for inspection due to whatsoever reason, the complete inspection expenditure of SAPDC engineer(s) as per actual shall be chargeable to the contractor.

1.20.2.29 Only calibrated testing & measuring instruments shall be used while performing tests during manufacturing and erection, testing & commissioning at site by the contractor.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Copy of the calibration certificates will be submitted to SAPDC/Consultant by the contractor during inspection as an evidence.

1.20.2.30 Non-conformities observed during manufacturing, shop testing, handling, packaging, transportation, storage, preservation, erection, testing & commissioning are required to be intimated by the contractor (Format for reporting, F-060-04 issue 2.0 rev 01, Total 5 pages). The acceptance/rejection of the non-conformities will be at the discretion of SAPDC.

1.20.2.31 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the acceptance of SAPDC. Action taken in accordance with decision of disposal of non-conformity for repair / rework / modification of the item / equipment and to prevent re-occurrence. The corrective and preventive action may involve modification of item / equipment, change in procedure and system etc. to achieve quality improvement at all stages and levels.

1.20.2.32 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the SAPDC to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings etc.

1.20.2.33 No material shall be dispatched from the manufacturer's works before the same is duly accepted, subsequent to pre dispatch/final inspection including verification of records of all previous tests/inspection by SAPDC and duly authorised for Dispatch by issuance of Material Dispatch Clearance Certificate (MDCC).

1.20.2.34 The test reports of type tests conducted as per contract, in line with requirement stipulated in the technical specification / quality plan should be got accepted from SAPDC/Consultant before final inspection / issuance of MDCC.

1.20.2.35 All materials used or supplied shall be accompanied by valid and approved material certificates and tests and inspection reports. These certificates and reports shall indicate the heat numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it to ensure physical correlation and traceability of material vis-a-vis test certificate. Such identification no. shall remain same and verifiable for all stages of manufacturing and installation.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.20.3 QA DOCUMENTATION

1.20.3.1 The contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan.

1.20.3.2 Each QA Documentation shall have a project specific Cover Sheet bearing name and identification number of equipment including index of its contents with page control on each document. The QA Documentation file shall be progressively completed by the Contractor/sub-vendor to allow regular reviews by all parties during the manufacturing. The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-ROM may be issued not later than three weeks.

1.20.3.3 Before dispatch / commissioning of any equipment, the Contractor shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The Contractor will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

1.20.3.4 The contractor shall be required to submit copies of the following quality assurance documents in original duly reviewed and accepted by contractor along with the request letter for issuance of MDCC (Material Dispatch Clearance Certificate):

- QUALITY PLAN CHECK LIST.
- MATERIAL MILL TEST REPORTS ON COMPONENTS AS SPECIFIED IN QUALITY PLAN.
- SKETCHES AND DRAWINGS USED FOR INDICATING THE METHOD OF TRACEABILITY OF THE RADIOGRAPHS TO THE LOCATION ON THE EQUIPMENT.
- NON-DESTRUCTIVE EXAMINATION RESULTS REPORTS INCLUDING INTERPRETATION REPORTS.
- CALIBRATION CERTIFICATE OF ALL METERS & MEASURING INSTRUMENTS PROPOSED TO BE SUPPLIED AS PART OF RELEVANT BILLING BREAKUP ITEM.
- ROUTINE TEST REPORTS FOR TESTING REQUIRED AS PER APPLICABLE CODES AND STANDARDS REFERRED IN THE SPECIFICATIONS.

- INSPECTION REPORTS DULY SIGNED BY AUTHORIZED REPRESENTATIVE OF SAPDC AND CONTRACTOR FOR THE AGREED CUSTOMER HOLD POINTS.
- ALL THE ACCEPTED DEVIATIONS SHALL BE INCLUDED WITH COMPLETE TECHNICAL DETAILS.
- LIST OF BALANCE POINTS IF ANY.
- CERTIFICATES IN RESPECT OF CALIBRATION, WELDERS & BRAZERS QUALIFICATION ETC.
- COPY OF ALL REFERENCE DRAWINGS AND REFERENCE TECHNICAL DOCUMENTS
- ACCEPTANCE OF TYPE TEST REPORTS BY SAPDC/CONSULTANT.

1.20.3.5 Similarly, the Contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/procedures, within 2 weeks after commissioning of individual system.

1.20.3.6 On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Consultant and other set to SAPDC. For the particular case of phased deliveries, the complete quality document to the SAPDC/Consultant shall be issued not later than 3 weeks after the date of the last delivery of equipment.

1.20.4 ASSOCIATED DOCUMENTS / FORMATS

- F-060-01 VENDOR / SUB-VENDOR ASSESSMENT SHEET
- F-060-02 QUALITY PLAN SUBMISSION BY CONTRACTOR.
- F-060-04 NON-CONFORMANCE REPORT (NCR)
- F-060-06 INSPECTION CALL REQUEST.

The above formats are attached at Annexure – E.

1.21 Safety

1.21.1 Safety of personnel

All equipment and services provided under this contract shall abide by international standards commonly accepted in the hydroelectric utility industry for safety of personnel whether involved with operation or maintenance.

1.21.2 Safety of operation

All equipment and services provided under this contract shall abide by commonly accepted standards for safety of operation.

The various system and sub-systems supplied under this contract shall be designed to follow and operate under a clear hierarchical structure:

- plant control level,
- unit control level,
- functional control level, functional drive group level,
- Local drive level.

Each hierarchical control level shall perform its specific tasks and always depend on the subordinate lower control levels. In general, should a higher control level failure occur, the lower control level shall not be affected and shall be able to control the power plant with full safety.

The Contractor shall accordingly build into the "Electrical & Mechanical System" adequate levels of autonomy, independence, redundancy and functional distribution to insure that safety is maintained at all times.

1.22 Earthing

Earthing terminals for equipment of these specifications shall form part of equipment supplies. The contractor shall connect the earthing conductors to these terminals as required.

Risers from earthing bus shall be in the scope of purchaser. However, extension from these risers to the equipment shall be in the scope of supplier in the Power House, Transformer Hall, Switchyard and Butterfly Valve House.

However, overall earthing arrangement required for HT panel, LT panel, DG set, motor & motor control panels etc. at isolated location such as Dam Site, TRT Outfall area and Surge Shaft either by pit earthing or counter poise etc. shall be in the scope of supplier including civil works, design, material supply (for main earthing risers, interconnection, charcoal, salt, Bentonite etc.), erection, testing & commissioning etc.

1.23 Completeness of the specification

Any fittings, accessories, equipments or any other things required for successful commissioning of Arun-III Hydro Electric Project, though may not have been specifically mentioned in the specification but are usually necessary for the completeness of the equipment shall be deemed to be included in the specification

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

and shall be supplied by the contractor without any extra cost to the Employer.

1.24 Packaging and Shipment

The contractor shall wrap, pack and crate all plant included in the work or part thereof, suitable for shipment to a tropical location, facilitating proper handling and protection from damage in rail, truck, ocean or air shipment as applicable. An approved drying agent, such as Silica Gel, shall be packed in containers or packages holding plant which may be adversely affected by moisture or excessive humidity.

All packing crates shall be clearly marked before shipping to indicate the contract number, shipping address, volume, weight, name, number and unit number of the contents, slinging and weight bearing points.

All plant parts shall be marked to facilitate erection. Each packing crate shall contain a packing list in a waterproof envelope. Parts shall be described and also identified by their numbered marking in the packing list.

Three copies of the packing list shall be forwarded to the purchaser prior to dispatch. The ownership of packaging materials shall be of Employer. All wooden packaging crates and steel support structures shall be dumped to the designated area within 5kms of the power house as per the direction of Engineer in charge.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION IA

ANNEXURES

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE-I

MAKES OF SUB-VENDOR ITEMS

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	STEEL	SAIL		
		TISCO		
		JINDAL		
		ESSAR		
2.	HOOKS	STEEL FORGING & ENGG. CO.,	KOLKATA	
		SIMRITI FORGING		
		KARACHIWALA		UP TO 25T CAPACITY
3.	GEAR COUPLINGS	ALLIANCE		
		FLEX-TRANS (formerly known as HICLIFF)		
		SAHARA		
		NUTECH		
		OEM		
4.	WIRE ROPE	USHA MARTIN		
		FORT WILLIAMS		
		BHARAT WIRE ROPES		
5.	BEARINGS	SKF		
		FAG		
		TATA		
		NBC		
6.	MOTORS	SIEMENS		
		NGEF (up to 15KW)		
		CROMPTON GEAVES		
		KIRLOSKAR ELECTRIC CO LTD.		
		BHARAT BIJLI		
		MARATHON		
		ABB		

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		GE-POWER	CHENNAI	(FOR LT MOTORS ONLY)
		LAXMI HYDRAULICS PVT. LTD	SOLAPUR-MAHARASHTRA	(FOR LT MOTORS ONLY)
		RAJINDRA ELECT INDUSTRIES		(FOR LT MOTORS ONLY)
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		
		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		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
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		

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		PHILIPS		
19.	PVC POWER CABLES	APAR INDUSTRIES LTD.	MUMBAI	
		CORDS CABLE INDUSTRIES LTD.	NEW DELHI	
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		GOYOLENE FIBRES (INDIA) PVT.LTD	MUMBAI	
		GOVIND CABLE INDUSTRIES	KOLKATA	
		GUPTA POWER INFRASTRUCTURE LIMITED	BHUBNESWAR	
		HAVELLS INDIA LIMITED	NOIDA	
		KEI INDUSTRIES LTD.	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	
		KEC INTERNATIONAL LIMITED	MUMBAI	
		MANSFIELD CABLES COMPANY LTD.	NOIDA	
		NICCO CORPORATION LTD.	KOLKATA	
		PARAMOUNT COMMUNICATIONS LTD.	NEW DELHI	
		POLYCAB WIRES PVT. LTD.	MUMBAI	
		RADIANT CORPORATION PRIVATE LIMITED	HYDERABAD	
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD.	VADODARA	
		SRIRAM CABLES PVT.	NEW DELHI	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		LTD.		
		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	
		KEC INTERNATIONAL LIMITED	MUMBAI	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		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	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		CRYSTAL CABLE INDUSTRIES LTD	KOLKATA	
		DIAMOND POWER INFRASTRUCTURE LTD	VADODARA	
		GEMSCAB INDUSTRIES LTD	NEW DELHI	
		GOVIND CABLE INDUSTRIES	KOLKATA	
		GUPTA POWER INFRASTRUCTURE LIMITED	BHUBNESWAR	
		HAVELLS INDIA LIMITED	NOIDA	
		KEI INDUSTRIES LTD	NEW DELHI	
		KRISHNA ELECTRICAL INDUSTRIES LTD	GWALIOR	
		KEC INTERNATIONAL LIMITED	MUMBAI	
		MANSFIELD CABLES COMPANY LTD	NOIDA	
		PARAMOUNT COMMUNICATIONS LTD	NEW DELHI	
		POLYCAB WIRES PVT. LTD	MUMBAI	
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD	VADODARA	
		SPECIAL CABLES PVT. LTD	NEW DELHI	
		SCOT INNOVATION WIRES AND CABLES PVT. LTD	SOLAN	
		SRIRAM CABLES PVT. LTD	NEW DELHI	
		TORRENT CABLES LTD	AHMEDABAD	
		THERMO CABLES LTD	HYDERABAD	
		TIRUPATI PLASTOMATICS PVT. LTD	JAIPUR	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
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		
		ALLIED TRADERS & EXPORTERS	NOIDA	
		BALIGA LIGHTING	CHENNAI	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		EQPT.PVT.LTD.		
		ELECTROMAC INDUSTRIES	MUMBAI	
		INCAB	KOLKATA	
25.	PUSH BUTTONS	SIEMENS		
		L&T		
		BCH		
		SCHNEIDER		
26.	LIMIT SWITCHES	SPEED-O-CONTROL		
		ELECTROMAG		
27.	MASTER CONTROLLER	SPEED-O-CONTROL		
		ELECTROMAG		
28.	SAFETY SWITCHES	ALSTOM		
		L&T		
		SIEMENS		
29.	PENDENT PUSH BUTTON STATION	OEM		
30.	INDICATING LAMPS	TECKNIC		
		BCH		
		SIEMENS		
		STANDARD		
31.	MCB	MDS		
		INDO COPP		
		STANDARD		
		SIEMENS		
		L&T		
		ABB		
		SCHNEIDER		
32.	PANELS	OEM		
		RITTAL		

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		PYROTECH		
33.	RESISTANCE BOXES	ENAPROS		
		OEM		
34.	FIRE EXTINGUISHERS	ASKA EQUIPMENTS LTD.		
		ASHOKA ENGINEERING COMPANY		
		KANADIA FYR FYTER PVT. LTD		
		NITIN FIRE PROTECTION INDUSTRIES LTD		
		NEW ENGINEERING CORPORATION		
		SAFEX FIRE SERVICES LTD		
		UNITED FIRE EQUIPMENTS PVT. LTD		
		ZENITH FIRE SERVICES (INDIA) PVT LTD		
35.	VVVF	YASKAWA		
		ABB		
		SIEMENS		
		SCHNIEDER		
		FUJI ELECTRIC		
		MITSUBISHI ELECTRIC		
36.	SHROUDED DSL	SUSHEEL		
		STROMAG		
37.	ANTI COLLISION DEVICE	ELECTRONIC SWITCHES INDIA		
38.	LOAD CELL	IPA		
		SARTORIUS		
39.	RRC	ACROPOLIS ENGINEERING	-	
		SNT CONTROLS	-	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
40.	GEAR BOX	OEM		* = Applicable for Geared Motors only
		ELECON ENGINEERS		
		SHANTI GEARS		
		PBL*		
		NAW*		
		NORD*		
		SEW*		
		BONGFILIOLI*		
41.	RAIL	JSPL		
		SAIL		
42.	LIGHTING FIXTURES, LAMPS	BAJAJ ELECTRICALS LTD.		
		PHILIPS		
		CROMPTON		
		GE		

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 FINALISED AFTER AWARD OF CONTRACT DURING DETAILED ENGINEERING. HOWEVER THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE-II MANDATORY SPARES

Sr. No.	Description of spares	Total Quantity	Remarks
1)	Pair of brake shoe with lining for each size of brake used viz. D.C. operated E.M, or Hydraulic thruster operated.	2 Sets	
2)	Pair of brake linings with rivets for each size of brake used.	2 Sets	
3)	Main springs for each size of brake used.	2 Nos.	
4)	Brake coils for each size of brake used.	2 Sets	
5)	Thruster of each size used.	1 No. each	
6)	Pair of oil seals for each gear box used on crane.	2 Sets	
7)	Contactors of each size used.	2 Sets	
8)	Fixed & moving contacts of each size contactor used.	2 Sets	
9)	3 Nos. Coils for each size of contactor used.	1 Set each	
10)	Overload relay for each motor.	1 No.	
11)	3 No. fuse links of each sizes used on crane	2 Sets	
12)	1 Printed circuit breaker of each size and type	1 Set	
13)	Complete set of lamps for lightning and signals	1 Set	
14)	Fuse links of each size used	2 Sets	
15)	Segment of DSL including fitting, jointing, clamping etc.	Equivalent to 1 phase installed length	
16)	LT Bearings	50% of installed bearings in crane	
17)	CT Bearings	2 no.	
18)	Motor of each size	1 no.	
19)	Flood light illumination	50 % of installed	
20)	Load cell	1 set	
21)	Indication lamp of DSL	1 set	
22)	MCCB and Fuses	1 set each	
23)	Auxiliary relay, contactor and timers	5 nos. each	
24)	Communication Card/cable	One set for one complete crane	
25)	I/O Card	One set for one complete crane	
26)	Processors	One set for one complete crane	
27)	Indicating lamps	One set for one complete crane	
28)	VVVF Drive	One set for one complete crane	
29)	Items for completeness of system as per clause no. 23.1.1 (H) OF CUST. SPEC as attached with Sec-IA	10% of installation	

Note:-

1. Set for the particular equipment, would include all components required to replace the item, for example a set of bearing shall include all hardware normally required while replacing the bearings. It is further, intended that the assembly / sub-assembly which have different orientation (like left hand or right hand, top or bottom), different direction of rotation or mirror image positioning or any other reasons which result in maintaining two different sets of the spares to be used for the subject assembly / sub-assembly, these shall be considered as different types of assembly/sub-assembly.

2. Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed.

3. In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.

4. Any item which is quoted as “not applicable” in the above list and is found to be “applicable” at a later date shall be supplied by the Bidder without any commercial implications. The Bidder shall note that if there in any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.

5. Mandatory spares shall not be dispatched before dispatch of corresponding main equipment. The spares shall be treated and packed for a long storage under the climatic condition prevailing at site.

6. All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares should include all mounted accessories like components, boards, add or items, fitting, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require any additional item. The vendors must conform the pair to pair compatibility of each electrical spares modules with the modules should be supplied in the original package. All electronic modules should be pre-set and/or pre-programmed for ready use at site. Alternatively, suitable instruction sheet indicating the details of required PCB jumper position, BCD which is setting, EPROM/PROM listing etc should be packed along with each module. Also a caution mark sign should be put on all such module which needs pre-setting/pre-programming before putting them in to service. The spare shall be treated and properly packed for long term storage.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

7. Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

8. The spares are to treated and packed by vendor for a long storage under the climate condition prevailing at site

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE III - TOOLS & TACKLES

1 lot of following 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.

a) One (1) set of wrench, spanner having sockets.
b) One (1) set of sliding bar for socket wrench.
c) One (1) torque wrench
d) One (1) each pen hammer 1 lb. & 2 lb.
e) One (1) set of Allen key set.
f) One (1) feeler gauge set.
g) One (1) oil can size 1 pint cap along with a funnel for oil filling.
h) Fuse Puller
i) Panel indicating lamp puller
j) One (1) hydraulically operated jack of capacity 20 tonnes.
k) One (1) tool box with lock and double keys.

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 crane, the same shall also be included as a part of maintenance tools by the bidder.

.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE IV

PAINTING SPECIFICATION

1. Painting specification for steel structures:-

Surface preparation: De greasing and Mechanical cleaning with wire brush or blasting according to SIS 055900, Grade 2 ½ .

Primer : Zinc Silicate of approved brand. - 2 coat, DFT 60 µm per coat.

Intermediate : MIO Epoxy paint- 2 coat, DFT 90 µm per coat

Finish Coat : Polyurethene coating- 1 coats, DFT 30 µm per coat.

Total DFT : 330µ

2. Painting specification for Indoor components such as motors, electrical parts etc:-

Surface preparation: blasting according to SIS 055900, Grade 2 ½ . Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Primer : Zinc phosphate epoxy - 2 coat, Total DFT 75 µm.

Finish Coat : Chlorinated rubber paint- 2 coats, Minimum DFT 30-40 µm per coat.

Total DFT : 135 – 155 µm

3. Gear Box :

Inside of all gear boxes will be covered with 2 coats of oil resistant paint.

Outside:

Type of coating system	No of coat	DFT µm per coat	Total DFT µm
Primer Coat			
Epoxy Base Zinc Phosphate Primer	2	25	50
Finish Coat			
Epoxy base Paint	2	25	50
Overall minimum DFT µm			100

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

4. Color Shade:

SL. No	Item Description	Color Shade	Remarks
1	Crane Structure	Golden Yellow shade 356 as per IS-5	Colour band-Black
2	Trolley and hook	Crimson shade 540 as per IS-5	
3	Motors	Light Gray shade 631 as per IS-5	
4	Control Panels	Light Gray (Powder coated) RAL 631 as per IS-5	
5	Gear Box	Light Blue (RAL : 5012) as per IS-5	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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:

BASIC ENGINEERING DRAWINGS/DOCUMENTS

S. N .	BHEL drawing No.	Title	No. of days for submission from date of LOI.	CATEGORY
1	PE-V0-437-501-A401	Manufacturing Quality Plan including Demonstration Test Procedure with sub vendor list for 100/20T crane for Transformer cavern area	21	A
2	PE-V0-437-501-A404	Mechanism Sizing Calculation, Motor Selection & VVFD Selection for 100/20T crane for Transformer cavern area	21	A
3	PE-V0-437-501-A405	General arrangement and assembly drawing including wheel load details for 100/20T crane for Transformer cavern area with CT DSL details	21	A
4	PE-V0-437-501-A406	Crab sub assembly for 100/20T crane for Transformer cavern area with CT wheel assembly	28	I
5	PE-V0-437-501-A409	Main and Auxiliary hook block assembly with details of hook, nut and check plate for 100/20T crane for Transformer cavern area	28	I
6	PE-V0-437-501-A420	Crane Operational write up For 100/20T crane for Transformer cavern area	35	I
7	PE-V0-437-501-A432	Gantry Rail installation and Sole plate, Anchor bolt drawing, rail clamp details/ rail fixing details and Grouting Detail / procedure for 100/20T crane for Transformer cavern area	21	I
8	PE-V0-437-501-A435	Erection hook, lugs, plates etc. details for 100/20T crane for Transformer cavern area	21	I

OTHER DRAWING/DOCUMENTS

S.N .	BHEL drawing No.	Title	Schedule of submission	CATEGORY
1	PE-V0-437-501-A403	Data sheet of motors for 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on Mechanical sizing calculation(PE-V0-437-501-A404)	A
2	PE-V0-437-501-A412	Structural calculations for 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	A

3	PE-V0-437-501-A417	All Electrical, Control Drawings and Schematic circuit diagram of all panels ,Cable Block & Termination Diagram, Coordination of fuse, MCCB, Power contactors, JB/MB/Kiosk Diagram, BOM Including earthing diagram for 100/20T crane for Transformer cavern area	7 days after CAT II approval /clearance from BHEL on Mechanical sizing calculation(PE-V0-437-501-A404)	A
4	PE-V0-437-501-A418	"General Arrangement of a) Protective panel b) Main hoist panel c) Aux. hoist panel d) Cross Travel panel e) Long Travel panel. f) Pendent g) Remote Radio Control for 100/20T crane for Transformer cavern area	7 days after CAT II approval /clearance from BHEL on Schematic Circuit diagram(PE-V0-437-501-A417)	I
5	PE-V0-437-501-A419	Cable Sizing and cable schedule for 100/20T crane for Transformer cavern area	7 days after CAT II approval /clearance from BHEL on Schematic Circuit diagram(PE-V0-437-501-A417)	A
6	PE-V0-437-501-A421	Type test certificate (for motors)for 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on Motor Datasheet(PE-V0-437-501-A403)	A
7	PE-V0-437-501-A423	Mandatory spare parts list for 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on Mechanical sizing calculation(PE-V0-437-501-A404) & Schematic Circuit diagram(PE-V0-437-501-A417)	A
8	PE-V0-437-501-A427	Data sheet and Catalogue of every component of 100/20T crane for Transformer cavern area with painting details	7 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	A
9	PE-V0-437-501-A433	Manufacturing Quality plan of motors (above 50KW) for 100/20T crane for Transformer cavern area (if applicable)	14 days after CAT II approval /clearance from BHEL on Mechanical sizing calculation(PE-V0-437-501-A404)	A
10	PE-V0-437-501-A425	Erection Procedure for 100/20T crane for Transformer cavern area	28 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	I
11	PE-V0-437-501-A408	General arrangement for PVC shrouded DSL for 100/20T crane for Transformer cavern area	7 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	I
12	PE-V0-437-501-A414	O & M Manual, Component wise weight schedule, lifting arrangement & safety arrangement for 100/20T crane for Transformer cavern area	28 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405), Mechanical sizing calculation(PE-V0-437-501-A404) & Schematic Circuit diagram(PE-V0-437-501-A417)	I
13	PE-V0-437-501-A410	Long travel Machinery Assembly with LT wheel assembly For 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	I
14	PE-V0-437-501-A415	Detailed BOM/BOQ for 100/20T crane for Transformer cavern area	28 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405), Mechanical sizing calculation(PE-V0-437-501-A404) & Schematic Circuit diagram(PE-V0-437-501-A417)	I

15	PE-V0-437-501-A430	Electrical load for 100/20T crane for Transformer cavern area	7 days after CAT II approval /clearance from BHEL on Motor Datasheet(PE-V0-437-501-A403)	I
16	PE-V0-437-501-A450	Crane lubrication drawing For 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	I
17	PE-V0-437-501-A424	Packing for 100/20T crane for Transformer cavern area	21 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405), Mechanical sizing calculation(PE-V0-437-501-A404) & Schematic Circuit diagram(PE-V0-437-501-A417)	I
18	PE-V0-437-501-A436	Girder Joints details (bolted splice plate 100/20T crane for Transformer cavern area	14 days after CAT II approval /clearance from BHEL on G.A. of Crane(PE-V0-437-501-A405)	I

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 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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE VI – PACKING PROCEDURE

COMMON GUIDELINES FOR PACKING

1. **GENERAL:**

The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit & storage. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage of materials.

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.

2. **TYPES OF PACKING:**

The following 5 types of packing have been standardized for packing of General Components/ Assemblies.

1) **'OP'** - Open Type.

2) **'PP'** - Partially Packed.

3) **'CP'** – Crate/Box Packing - Components/Equipment requiring physical protection.

4) **'CQ'** - Case Packing – Machined components-Small & Medium Components/ Assemblies/ Equipment which require corrosion & physical protection.

5) **'CR'** - Case Packing – Electrical/Electronic Components/ Assemblies, which require special packing viz. Water Proof, Shock Proof etc…

3. **DESCRIPTION OF TYPES OF PACKING:**

The various types of packing, as standardized above, are described below.

3.1 'OP' - Open Type

In case, of components which are not affected by water & dust and do not require special protection, are generally not machined, shall be sent as open packages. However, these components may be sent in crates, wherever necessary.

3.2 'PP' - Partially Packed

Components which need special protection at selected portions only shall be despatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces should be protected with 100GSM(Colourless) Multi Layered Cross Laminated Polyethylene
Film. All sharp corners and edges shall be protected by rubber mats to prevent damage to the polyethylene film.

3.3 'CP' - Crate Packing

Assemblies/Components which need only physical protection from the point of view of handling shall be despatched duly packed in crates.

3.4 'CQ' - Case Packing - Machined Components/Assemblies/Equipment

Small and medium sized components/assemblies/equipment due to size/weight and to avoid handling and pilferage problems shall be packed in Case/Containers. Wherever required adequate quantity of silica gel or VCI Powder/Tablets, packed in thin muslin cloth cotton bags shall be suitably placed. Small machines/components of less weight shall be provided with suitable cushioning by Rubberised coir. The components inside the case shall be entirely covered with100GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film, wherever required. This may be prescribed for electronic parts/critical machined components/surfaces.

For mechanical product like valves where motors are separately securely wrapped in polyethylene, the requirement of individual component wrapping shall be exempted.

3.5 'CR' - Case Packing - Electrical & Electronic Components/Assemblies

Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons. Adequate quantity of Silica gel packed in cotton bags of 100grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with 100GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film before being packed in the cases. VCI Powder/Tablets can be used as an alternative to Silica Gel.

Empty space in the cartons shall be filled with rubberized coir to get proper cushioning effect. The cartons shall be manufactured from corrugated Fiber Board.

4 PREPARATION OF PACKING CASES

4.1 DIMENSIONS:

a) Thickness of planks for Front, rear, top and bottom sides and binding, jointing battens shall be 25/20mm +2/-3 mm as per applicable drawings of the respective units.

b) Width of all planks including the tongue shall be more than 125mm and after plaining it shall be minimum 100mm.

c) Minimum number of planks shall be used for a shook.

d) Horizontal, vertical, diagonal planks shall be given for binding (number of such planks depend on the dimension of panel.

e) Width of binding planks shall be minimum 100mm.

f) Distance between any 2 binding planks shall be less than 750mm.

g) diagonal planks shall be used in between vertical binding planks when distance between inner to inner of vertical planks is more than 750mm

h) Distance of the outer edges of these planks from the edge of case shall be less than 250mm.

i) Diagonal planks are not required for top planks and width side, if the width of pallet is less than 750mm.

4.2 JOINTING OF PLANKS

Single length planks shall be used for cubicles whose overall length is less than 2400mm. For cubicles of length more than 2400mm, jointing is permitted. The jointing shall be done with one single or maximum of 2 planks of wood same as other planks of width 250 mm (minimum) with two rows of nails on either side of the joint in zigzag manner. From the joint along height side, it shall be of lap joint with overlap of at least the width of plank.

4.3 TONGUE AND GROOVE JOINTS

Two consecutive planks shall be joined by tongue and groove joint. Depth of tongue shall be 12+1 mm, thickness of tongue shall be 8 +1 mm. The groove dimensions shall be such that the tongue fits tightly into the groove to make a good joint. This type of joint can be done based on the product requirement wherever required.

4.4 PERMISSIBLE DEFECTS

Wood shall be free from knots, bows, visible sign of infection and any kind of decay caused by insects, fungus, etc.

End splits: Longest end splits at each end shall be measured and lengths added together. The added length shall not exceed 60mm per meter run of shook's. Wood pins shall be used to prevent further development of split.
Surface cracks: Surface cracks with a maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

4.5 OTHER MATERIALS

4.5.1 NAILS
The dia. of the nails shall be 3.15mm. The length of the nails shall be 65mm wherever two planks of 25mm thickness are joined and 75mm wherever a 25mm planks is joined to a 50mm plank.

4.5.2 BLUE NAILS
These are used for nailing bituminized Kraft paper/hessian cloth to the planks. The length of the nails shall be 16mm.

4.5.3 HOOP IRON STRIPS
These are used for strapping the boxes. The width of the strips shall be 19+1mm and thickness 0.6+0.01mm. The material shall be free from rust.If sufficient nailing is done for bigger boxes, strapping need not be done.

4.5.4 CLIPS
These shall be used for strapping the hoop iron strips on the boxes.

4.5.5 BRACKETS
These brackets are used for nailing to the corners of cubicle boxes. The brackets shall be of mild steel of thickness min 2mm and width 25+1mm. The brackets shall be of "L" shape, the length of each side being 100+2mm. Two holes shall be provided towards the end of each side for screwing /nailing.

4.5.6 FASTENERS
Bolts, double nuts, spring washers will have to be used for packing of some special items like transformers, reactors, breakers, etc., to hold the job to the bottom plank of the box. The bolts, nuts, washers will be provided by the vendor. Drilling of holes will have to be done using contractor's tools.

4.5.7 MULTI LAYERED CROSS LAMINATED POLYTHELENE FILM
100GSM (Colourless) Multi Layered Cross Laminated Polythelene Film are used to make covers to the jobs individually. The cross lamination gives qualities of extra toughness, together with flexibility and lightness coupled with good weather resistance to ultra violet rays.

4.5.8 RUBBERISED COIR:
The rubberized coir is used as cushioning material. For the packing of loose items, items are to be arrested by using rubberized coir. For the packing of cubicles rubberized coir of thickness 25mm and width 75mm shall be used.

4.5.9 FOAM RUBBER / 'U' FOAM:
This is used for covering the delicate items. This material is provided by the vendor.

4.5.10 MARKING PLATE:
This shall be of anodized aluminium sheet. Size of the marking plate shall be maintained minimum of size as per the details specified in the Figure 4.

4.5.11 PACKING SLIP HOLDER:
This shall be of galvanized iron tinned sheet /Aluminium sheet

4.5.12 SILICA GEL:
Silical gel shall be used for such products only where moisture needs to be avoided.

4.5.13 COTTON BAGS:

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

These are used for holding silica gel. The bags shall have the following matter indicated on them:

BHEL-UNIT NAME PLACE -PINCODE
SILICA GEL -INDICATING TYPE
BLUE : -ACTIVE
ROSE : -REDUCED ACTIVITY
WHITE : -NO ACTIVITY. TO BE REPLACED WITH FRESH SILICA GEL

4.5.14 COTTON/ PLASTIC TAPE:
This is used for tying small items. And also to prevent vibrations of moving parts within the cubicles.

4.5.15 MARKING INK:
The ink used normally is black in color. In some special cases other color also will have to be used. The ink shall be non-fading/indelible and non-washable by water.

4.5.16 POLYETHYLENE BAGS:
These are to be used for keeping the Packing slips. The bag shall be of size 70mm X 100mm (minimum).

4.5.17 Hessian cloth, twine thread, paint will have to be used in packing certain items.

4.5.18 Mechanical Latching clamps:
For CLW Railway panels and similar Panels self-locking clamps can also be used on need basis in conjunction with or apart from regular bolt and nut fixing arrangement. For reusable boxes, these clamps provide easy locking and unlocking arrangement. These clamps will be made available from BHEL in some cases.

4.5.19 STICKERS
The following stickers to be put by the vendor on cubicles/Boxes after packing.

1) Case No sticker: 2 nos. Size 25.Cm x 0.45Cm
2) BHEL Monogram sticker: 1 no. Size 1.75Cm x 2.3Cm
3) Address sticker: 2 nos. Size 3.8Cm x 3.0Cm
4) Direction sticker “Front” & “Back” - 4 nos. Size 2.0Cm x 0.75Cm
5) Chain Mark Sticker: 4 Nos. Size – 3.0Cm x 0.75Cm
6) "Fragile” sticker: 2 Nos. Size. 2.1Cm x 1.5Cm
7) "DO NOT STACK” sticker - 2 Nos. Size 3.0Cm x 2.2Cm

In place of stickers, writing all the details legibly with paint shall be allowed & respective units may take decision accordingly.

5. PACKING OF CUBICLES:

5.1 The packing is to be done as per clause 4 in all respects.

5.2 The cubicles are already fixed on wooden pallets. Hence the contractor need not arrange the bottom pallets normally.

5.3 The cubicles will be of different sizes both width wise and lengthwise. The cubicles may be made up of single suite, 2 Suite, 3 Suite, 4 Suite, etc., The width of the cubicles generally varies from 400 mm to 1650mm.The length of the cubicle, generally varies from 1500 mm to 4800 mm. The height is normally 2430 mm. In some cases, the height may be less/more.

5.4 MULTI LAYER CROSS LAMINATED POLY FILM
The inner surface of 4 sides of shook's shall be nailed with Multi-layer cross laminated poly film (as per 4.5.7) using blue nails (as per 4.5.2) wherever 2 pieces of Cross laminated poly film are used, the joint shall

have an overlap of minimum 20mm.
The inner surface of top cover shall be nailed with Multi-layer cross laminated poly film (as per 4.5.7). This sheet shall project outside on 4 sides by at least 100mm and shall be nailed properly on sides. Joining of sheets should have overlap of minimum 20mm.
The cubicles shall be covered with Multi-layer cross laminated poly film (as per 4.5.7).

5.5 SILICA GEL:
Silica gel (as per 4.5.12) packed in cotton bags shall be kept at different places inside the cubicle as per BHEL-Unit directions. Each suit of cubicle shall be provided with 1 kg of Silica gel (for a 4 suit cubicle 4 kgs of Silica Gel to be used. The bag containing silica gel to be as per 4.5.13).

5.6 LOOSE PARTS:
Any loose parts in the cubicles shall be tied using cotton/ plastic tape. Wooden battens shall be provided wherever necessary.

5.7 WOODEN BATTENS:
In case of cubicle which are not rectangular in shape like control desks, sufficient number of wooden rafters/battens of proper size shall be provided to give strength to the package.

5.8 RUBBERISED COIR:
Gap between the cubicle and the case shall be filled with rubberized coir (as per 5.5.8) with distance between consecutive layers less than 500mm.

5.9 CLAMPING:
Packing shall be bound at edges by nailing M.S. Clamps / Brackets (as per 5.5.5). Each vertical edge shall have minimum 3 clamps. Top horizontal edges will have one clamp for every meter length of package. However, minimum 4 clamps shall be nailed at the top for any cubicle.

5.10 PACKING SLIP:
Packing slip kept in the polyethylene bag (As per 5.5.16) shall be placed in the box at appropriate place. In addition, one more packing slip covered in polyethylene cover and packing slip holder (as per 5.5.11) shall be nailed to front / rear of case.

5.11 MARKING PLATE:
One no. (As per 5.5.10) shall be nailed to the front side of the case.

5.12 CASE MOUNTING:
After complete packing, stencil marking of various details and marking of symbols shall be done as per BHEL instructions using indelible / non washable marking ink.

5.13 Different types (Typical) of Cubicles with sizes for Packing
1. Single suite cubicle - 900 x 950 x2500
2. Two suite cubicle - 1650 x 950 x 2500
3. Three suite cubicle - 2400 x 950 x2500
4. Four suite cubicle - 3150 x 950 x 2500
5. Regulation cub - 1300 x 1350 x 2500
6. Thy cub - 2870 x 1350 x 2500
7. VFD Cub - 3800 x 1550 x 2500

6 PACKING OF LOOSE ITEMS/SPARES

1) Shape of cases shall be square, rectangular with single gabled roof or with double gabled roof depending on the nature of the job to be packed. Construction shall be as per drawings enclosed. Only gable will be additional as required.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

2) Wood with Tongue and Groove joint as per clause 4.3.

3) Width of planks shall be at least 100 mm. Width of binding planks (battens) shall be at least 75mm.

4) External surface of planks on front and rear shall be plane 100% (except bottom plank).

5) Inner surfaces of all 6 sides shall be lined with Multi Layered Cross Laminated Polythelene Film (as per clause 4.5.7) using blue nails.

6) Rubberized coir of minimum 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of box.

7) Internal packing: Items that go into the box shall be packed using 100GSM, (Colourless) Multi Layered Cross Laminated Polyethylene Film. Any space left between the job and the sides and the top of the box shall be filled with rubberized coir to get proper cushioning effect.

8) Certain items like transformers, reactors, breakers, etc., shall be bolted to the bottom of the box using bolts, nuts and washers.

9) Silica gel as per clause 4.5.12 held in cotton bags as per clause 4.5.13 shall be kept at proper places in the box.

10) Packing slip kept in polyethylene bag (clause 4.5.16) shall be placed in the box.

11) Marking plate as per clause 4.5.10 shall be nailed to side of the box.

12) Two numbers of hoop iron strips as per clause 4.5.3 shall be strapped tightly on the case using clips.

13) Stencil marking of various details and marking of various symbols shall be done as per BHEL instructions using indelible/non-washable marking ink.

14) Loose items to be kept inside the cubicle

- The components which are removed from cubicle for shipping purpose only, such as meters shall be kept inside the cubicle individually, kept in wooden box and tied firmly in bottom of Cubicle.
- Other items which are given loose in addition to cubicle shall be packed in separate boxes.

7 BOX SIZES

7.1 BOX SIZES

Table 1 – SPARES WOODEN BOX DETAILS

SNO	BOX TYPE	BOX SIZE (in mm)	BOX Wt (in KG)	Carrying Capacity
1	A	800 X 200 X 200	15	
2	B	1500 X 200 X 200	22	
3	C	2000 X 200 X 200	27	
4	D	1100 X 200 X 200	15	
5	E	200 X 200 X 200	5	
6	F	320 X 250 X 260	13	
7	G	320 X 250 X 430	16	
8	H	430 X 370 X 430	23	
9	I	1100 X 400 X 400	45	
10	J	1500 X 500 X 400	65	
11	K	2000 X 500 X 400	93	
12	L	2500 X 500 X 400	88	
13	M	900 X 600 X 600	100	

14	N	3000 X 400 X 400	60	
15	P	600 X 500 X 400	35	
16	Q	710 X 630 X 600	90	
17	R	850 X 630 X 670	102	
18	S	1000 X 770 X 670	140	
19	T	2500 X 850 X 800	180	
20	U	1500 X 700 X 700	120	
21	W	1200X900X600	120	
22	Y	450 X 200 X 200	10	

Table 2 – WOODEN BOX DETAILS

BOX TYPE	BOX SIZE (in MM)	BOX Wt (in KG)	Carrying Capacity
1	320X250X260	10	
2	320X250X430	15	
3	430X370X430	25	
4	670X670X470	65	
5	720X630X600	75	
6	1000X770X660	100	
7	1100X430X670	80	
8	1200X1200X900	80	
9	1300X770X1050	155	
10	2500X850X800	225	
11	2000X1500X1200	305	
12	1850X1050X1250	260	
13	2000X800X800	180	
14	2600X1500X1600	470	
15	250X250X600	20	
16	250X250X880	30	
17	300X300X700	25	
18	380X380X880	45	
19	510X510X1400	60	
20	570X570X1400	80	
21	575X575X1875	105	
22	3600X1100X1100	390	
23	900X500X800	110	
24	2000X950X740	225	
25	1600X1120X700	220	
26	2500X2000X1200	490	
27	2900X1900X1400	525	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

28	3000X1000X900	370	
29	3200X2200X950	450	
30	2150X1100X750	325	
31	2000X2000X700	130	
32	700X1200X1325	130	

TABLE 3 STEEL BOXES

S.NO.	TYPE	DIMENSION IN MM			WEIGHT	CARRYING CAPACITY (KGS)
		LENGTH	BREADTH	HEIGHT		
1	I	2480	1680	1500	339	4500
2	II	1200	900	600	61	2000
3	IIB	1800	850	950	115	2500
4	III	900	600	600	29	1000
5	IV	600	450	500	19	750
6	V	400	350	300	11	500

TYPICAL PATTERN OF WOODEN BOX

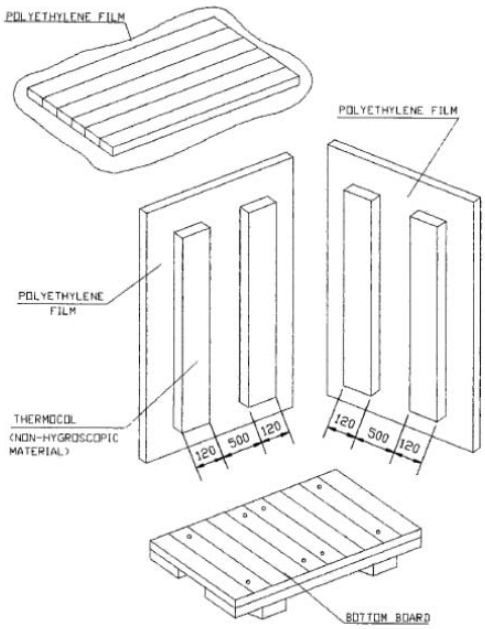


Figure 1

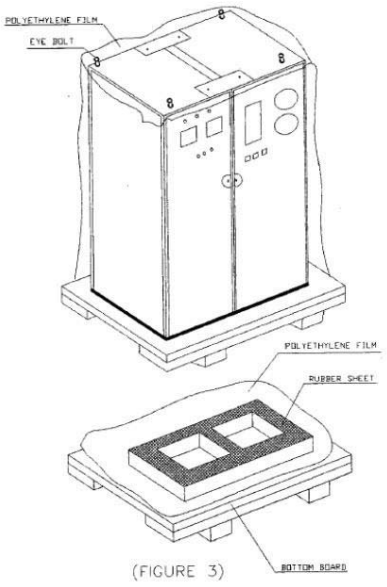


Figure 2

7.3 SEALED PACKING:

Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture. The components sub-assemblies and assemblies are completely covered with 2 layers of polyethylene sheet. All sharp corners and edges are to be protected by rubber mats to prevent the

polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.

8 MARKINGS/STENCILINGS

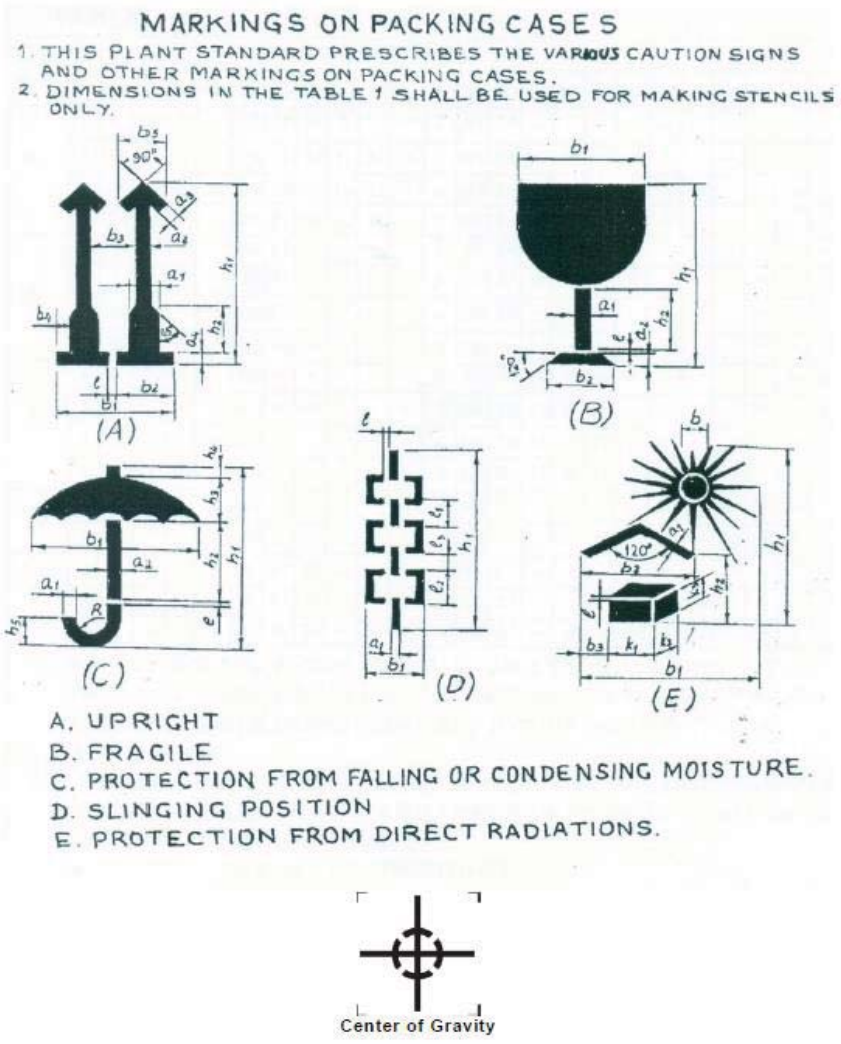


Figure 3

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

DESIGN-ATION		DIMENSION IN MM																						
		a1	a2	a3	a4	b1	b2	b3	b4	b5	b	l	h1	h2	h3	h4	h5	k1	k2	k3	l1	l2	l3	R
A	1	12	5	5	4	52	25	19	8	21		2	84	23										
	2	17	7	7	6	75	36	29	11	30		3	119	33										
	3	24	10	10	8	104	50	38	16	42		4	168	46										
	4	34	14	14	11	147	71	59	23	60		5	239	65										
B	1	5	5			50	33					2	84	25										
	2	7	7			71	47					3	119	36										
	3	10	10			100	66					4	168	50										
	4	14	14			142	94					5	239	71										
C	1	4	3			66						2	80	39	19	5	11							6
	2	6	4			85						3	114	55	27	7	16							9
	3	8	6			120						4	160	78	38	10	22							12
	4	11	9			170						5	227	110	54	14	31							17
D	1	6				30						4	148								30	30	10	
	2	9				42						5	209								42	42	14	
E	1	3				69	47	10			16	2	91	26				17	8	11				
	2	4				98	67	15			23	3	128	33				24	11	16				
	3	6				138	94	20			32	4	182	62				34	16	22				

Table 4

Black and Red Marking Ink to IS:1234 "Ink, Stencil, Oil Base, For Marking Porous Surfaces" or duplicating ink stencilling, oil base for marking porous surfaces.

All cases containing fragile items are to be stencilled with red marking and stencilling paint/ink **"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".**

Besides the caution signs the product information's shall be stencilled of letters with 13mm to 50mm height. In case of consignment consists of more than one package, each package shall carry its package no as given in shipping list. All caution signs shall be stencilled in high quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel.

Caution signs & other markings shall be stencilled on both the end shooks & the side shooks.

Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.

Note: Incase the size of package is small for using the stencils, then hand written letters/figures shall be allowed.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	BHEL – <unit> - <location> - <pin>				
CONSIGNEE					
MATERIAL					
CUSTOMER REF.			MO. NO.		
DESPATCH ADVICE NOTE NO			CASE NO		
DIMENSIONS(MM) L x B x H			NET WT –KGS	GROSS WT –KGS	
SPECIAL INSTRUCTIONS	HANDLE WITH CARE - KEEP DRY DO NOT DROP - DO NOT TILT				

Figure 4 – TYPICAL MARKING PLATE (225 X 170)

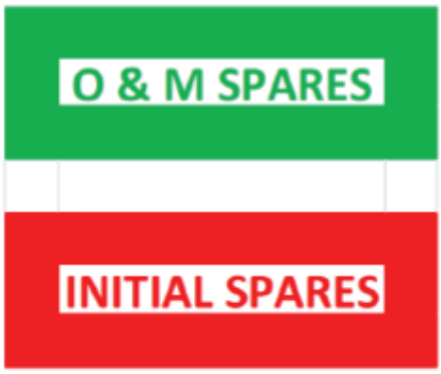


Figure 5

Easy spares [Initial and O&M] Traceability and Identification at units and as well as at sites:

9 STANDARD METHOD OF PACKING

Table 5 - Standard Method of Packing

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM
PRESSUE VESSELS								
TOWERS					O			
TANKS					O			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

VESSELS					O			
GASKETS	O							
FASTENERS	O							
COVERS		O						
EXCHANGERS								
HEAT EXCHANGERS					O			
TUBE BUNDLE	O							
SHELL					O			
AIR FIN COOLERS					O			
COLOUMNS, MOTOR SUSPENSIONS, PLENUM CHAMBERS, SCREEN GUARDS, ETC					O			
BEARING BLOCKS	O							
FANS	O	O						
MOTORS	O							
GASKETS	O							
FASTENERS	O							
TEST FLANGES			O					
TEST RINGS			O					
COVERS			O					
CRYOGENIC VESSELS								
COLD CONVERTERS					O			
HORIZONTAL STORAGE TANKS					O			
TRANSPORTATION TANK					O			
COLD BOX					O			
DRYING UNIT					O			
DRYING BOTTLES					O			
MOISTURE SEPARATORS					O			
SILENCERS					O			
ONGC SKIDS					O			
VAPORISER		O						
SPECIAL PRODUCTS								
SI/VI PIPING		O						
CRO BIO CONTAINERS	O							
DESCRIPTION	**CASE**	**CRATE**	**SKID**	**BUNDLE**	**BARE**	**DRUM**	**METAL DRUM**	**FIBRE DRUM**
AIR BOTTLES	O							
TITANIUM BOTTLE	O							
WAR HEAD CONTAINER	O							
MISSILE CONTAINER	O							
FUEL CONTAINER	O							
AIR LOCK ASSEMBLY	O							
BOILER DRUMS					O			
BOILER ITEMS								

COILS			O					
PANELS					O			
HEADERS			O		O			
FEEDERS								
MACHINED ITEMS								
SHELL SEGMENTS					O			
SHELL SEGMENTS IN STACKS					O			
SPHERE PETALS								
COLOUMNS, BASE PLATES, TIERCOS, PIPES, NOZZLE E1, F1, INTERNAL PIPES, PADS ETC.					O			
ROLLERS	O							
VALVE TRAYS								
VALVE TRAY COMPONENTS	O							
LATTICE GIRDERS		O						
FASTENERS	O							
GASKETS	O							
SUB CONTRACTS								
FAB STRUCTURALS					O			
SUPPORTING STRUCTURALS					O			
STRUCTURE SUB ASSEMBLY					O			
FAB PIPES					O			
GRATINGS					O			
STAIR CASES					O			
HANDRAILS/ PLATFORMS					O			
BOUGHT OUT COMPONENTS								
IRON & STEEL (LIKE PLATES, BEAMS, ANGLES, CHANNELS ETC.)					O			
PIPE FITTINGS								
CS PIPES, TUBES					O			
SS PIPES, TUBES					O			
FIN TUBES	O							
ELBOWS		O			O			
DESCRIPTION	**CASE**	**CRATE**	**SKID**	**BUNDLE**	**BARE**	**DRUM**	**METAL DRUM**	**FIBRE DRUM**
FLANGES	O	O						
VALVES	O							
GAUGES	O							
DEMISTERS		O						
ABSCRBANTS (LIKE MOLECULAR SIEVES, ACTIVATED ALUMINA, MOBILE SORBID)						O		
PAINT TINS		O						
PAINT DRUMS						O		
IGNITORS	O							

SPRAY NOZZLES	O							
ELECTRICAL INSTRUMENTATION								
MOTORS, PUMPS, COMPRESSORS, TURBINES	O							
SWITCH BOARDS, DISTRIBUTION BOARDS, STARTERS, JUNCTION BOXES		O						
INDICATORS, VIBRATOR SWITCHES	O							
CABLE BUNDLES, CABLE DRUMS					O			
CABLE TRAYS, CABLE RACKS, EARTHING MATERIAL		O						
OPERATIONAL SPARES	O							

10 PROCEDURE FOR HANDLING OF COMPONENTS

The purpose of this procedure is to protect the quality of the components/equipment while handling in various stages of manufacturing packing & despatching.

10.1 Adequate care shall be taken in handling the material, and components to avoid damage during receipts, storage issue manufacture & despatch operations.

10.2 Appropriate material handling equipment like fork lifters, cranes etc. shall be used where needed.

10.3 Lifting by crane and transportation by trolley of critical items and large components like rotors castings etc. shall be done carefully.

10.4 For critical items, where specified, special handling fixtures shall be used for lifting.

10.5 Slings and shackles used for lifting the components/equipment shall be checked for fitness and suitability before use.

10.6 Slings used on machined surfaces shall be suitably padded. No slings shall be used on journal surfaces.

10.7 Precision machined components like blades, catches, rollers etc. shall be lifted using suitable wooden pallets.

10.8 HANDLING OF COMPONENTS ON RECEIPT/DESPATCH

Before loading/unloading a packing case from the carrier look for the following shipping instructions painted on the packing case.

a) The markings showing the upright position.

b) The markings showing the sling position

c) Markings showing the fragile contents.

d) Other required markings as per clause no.10

10.8.1 Appropriate cranes and slings should be used for different components/ cases. Slings should normally make an angle as minimum as possible (width wise) but in no case more than 15º.

10.8.2 Handling and lifting should be done without jerks or impacts.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

10.8.3 Immediately after receipt of the goods, the packing should be examined all-round for any sign of damage. If necessary, lift the cover or a number of boards of the case so as to make the contents visible. In the event of sealed packing being used the plastic sheeting should not be damaged. It is imperative that the packing material is restored in original condition after the inspection.

10.8.4 On receipt of the equipment it should be checked with the shipping list and missing or damage if any should be reported immediately. It is important to arrange for immediate examination to determine the extent of the damage, the cause of the damage and where applicable the person or persons responsible for the damage. According to general practice when transporting by railway or by road vehicle the carrier concerned should be immediately called upon (within specified periods) for jointly establishing a statement of the damage. This is essential as a basis for a subsequent claim and possible damage report to the insurance company.

10.8.5 Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.

10.8.6 Silica gel and such other chemicals kept in the box as desiccants and indicators should also be left in the box itself.

11 GENERAL GUIDELINES FOR ODC TRANSPORTATION/DESPATCH

Based on the Dimensions/Weight indicated in the Transportation Sketch, the type of Trailer is decided and indicated in the Tender Enquiry.

11.1 TRANSPORTATION:

1. LOW BED TRAILERS (LB 8):

   Well Bed Length : 10000mm
   Over Gooseneck : 13000mm
   Width : 3000mm
   Carrying Capacity : 40MT

2. LOW BED TRAILERS (LB 16):

   Well Bed Length : 12000mm
   Over Gooseneck : 16000mm
   Width : 3000mm
   Carrying Capacity : 75MT

3. TOW TYPE TRAILERS (WITH FRONT DOLLEY 16 TYRES): 12000MM length
   (for Exceptional equipment length: 30000mm and above)

Bigger Dia equipment are loaded in the Well with overhanging.

Smaller Dia equipment with excess length are loaded over Gooseneck with rear hanging.
The Vehicle Dimensions are defined above are only guidelines for selection based on actual Dimensions/ Weight of the Consignment

11.2 PACKING:

For all ODCs, Wooden Saddles are cut to the diameter of equipment as per the Transportation Sketch.

Wooden Saddles	For Diameter up to 4000mm	For Diameter above 4000mm
Length:	1836/2743mm (6'0"/9'0")	3353mm (11'0")
Width:	300mm (1'0")	300mm (1'0")
Height:	Saddle + one/two wedges a top	Saddle + three/four wedges a top

Number of Saddles:	
Minimum	3 in case of Loading inside Well +1 when loaded on Gooseneck
Maximum:	4 in case of Loading inside Well +2 when loaded on Gooseneck

For Securing the equipment firmly on the Trailer, 19mm (3/4"), wire rope with 25mm (1") Heavy Duty Turn Buckles / BD Clamps are used as Lashing for the equipment.

12 GUIDELINES FOR HANDLING/LOADING/LASHING

- Jobs to be checked for complete painting before loading.
- Components to be lifted with Nylon belts. This protects painting, edges and attachments.
- All the components to be transported by putting inside the properly fabricated Crating
- Small components may fall down while transporting without closed crating and there are chances of missing of small parts. Hence, it is always better to transport small components in closed containers/crating. Loose to be being shipped in a closed crating.
- No component loaded over the crating.
- **LASHING:** Use Nylon belts only for lashing of all components. It prevents removal off painting and cut in the materials.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ANNEXURE-VII

SUPPLY PRICE PERCENTACE BREAKUP FOR TRANSFORMER CAVERN AREA DOUBLE GIRDER CRANE

SUPPLY PRICE PERCENTAGE BREAKUP FOR CRANE			
S. N.	**Details of Works or Equipment/System**	**Qty. (LOT / Nos.)**	**Percentage (%) Break up proposed for billing purpose during contract for Supply price**
1.	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, training, fill of lubricants & consumables and spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery as per SCC including warranty for **100T/20T capacity Double girder EOT crane with 11 m lift for Main hook, 11 m lift of Aux. hook, 14.5 m span, complete with all accessories including holding clamps, isolating switch** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	1 set	80.37 %
2.	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting along with all accessories forwarding, proper packing, shipment and delivery as per SCC including warranty for **PVC shrouded bus bar type DSL for 17.972 M bay length** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	1 set	1.0 %
3.	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting along with all accessories forwarding, proper packing, shipment and delivery as per SCC including warranty for **Gantry rail for 17.972 M bay length** for the total scope defined as per BHEL NIT & tender technical specification,	1 set	3.16 %

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	amendment & agreements till placement of order.		
4.	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting along with all accessories forwarding, proper packing, shipment and delivery as per SCC including warranty for **Temporary cable for operation of crane during erection stage of the plant (30M)** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	1 set	0.95 %
5	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting along with all accessories forwarding, proper packing, shipment and delivery as per SCC including warranty for **embedded parts, sole plate, anchor bolts and other accessories for rail fixing and DSL arrangement** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	1 set	7.84 %
6	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting along with all accessories forwarding, proper packing, shipment and delivery as per SCC including warranty for **6 pair of slings with suitable storage rack (100T, 60T, 40T, 20T, 10T,5T)** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	1 set	4.08 %
7	Total lump sum firm price inclusive of all prevailing taxes, duties and other levies for SUPPLY part comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting along with all accessories forwarding, proper packing, shipment and delivery as per SCC including warranty for **Power cable from 1 feeder of feeder board to Isolating switch(as defined in data sheet A)** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	1 set	1.15 %
8	Total lump sum price for **Maintenance tools and Tackles** for the total	1 set	1.45 %

	scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.		
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.

3. Any variation in length will be adjusted during detail engineering stage based on unit rates arrived for DSL, gantry rail, temporary cable, embedded parts, sole plate, anchor bolts and other accessories and power cable from 2, 3, 4, 5 & 7 above.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

CRANE CLEARANCE DIAGRAM

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

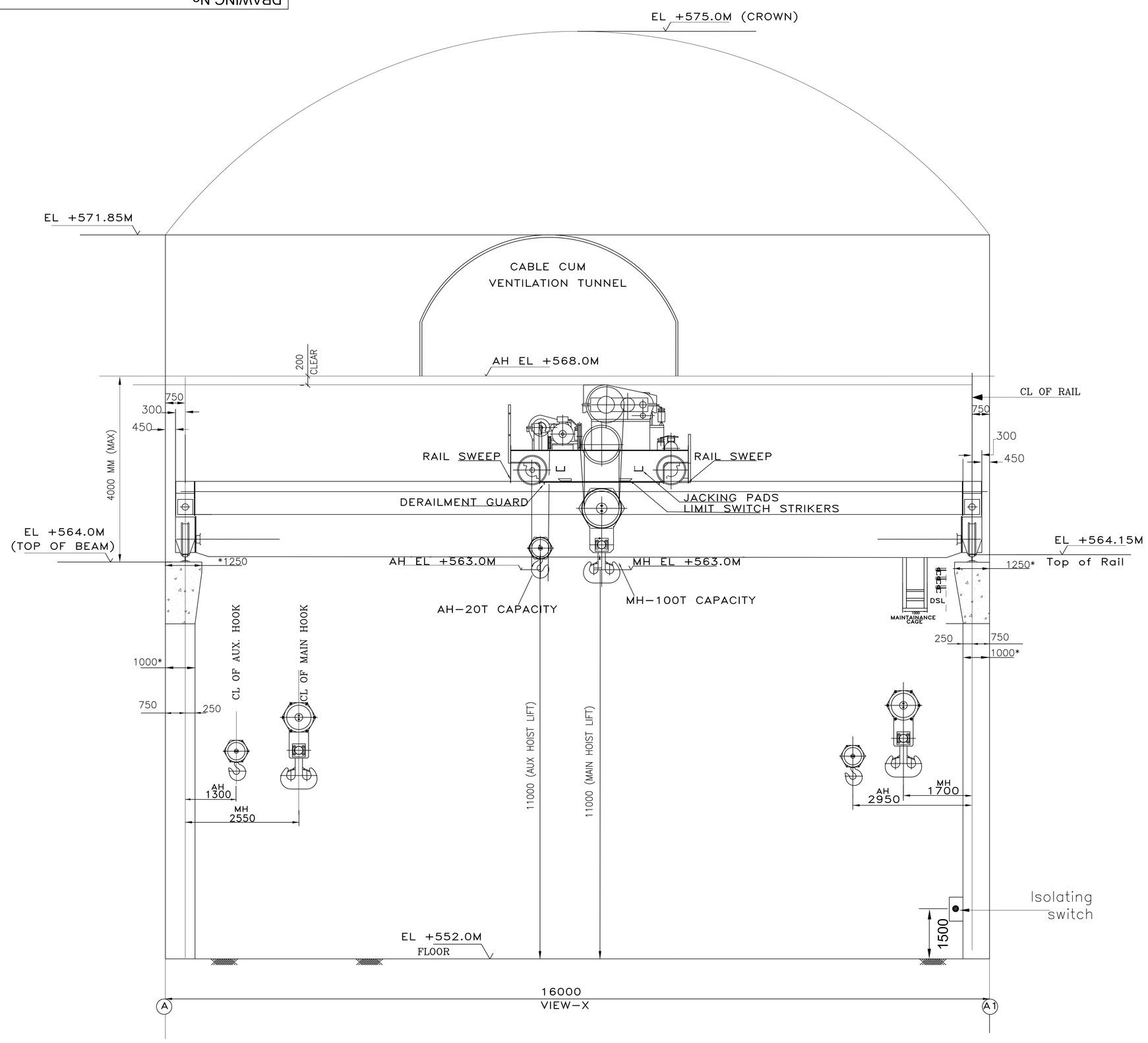
Fold-2 | ALL DIMENSIONS ARE IN MM | FIRST ANGLE PROJECTION | Fold-1

3 4 5 6

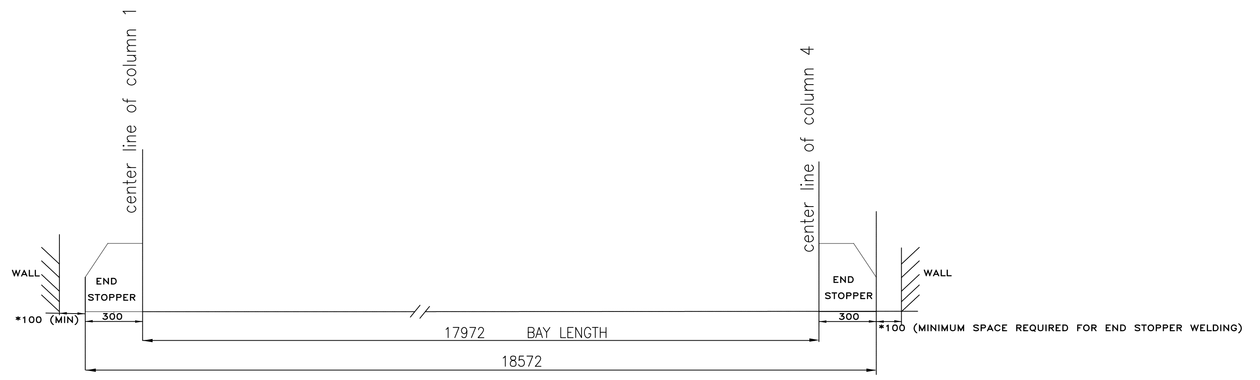
DRAWING No.

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.

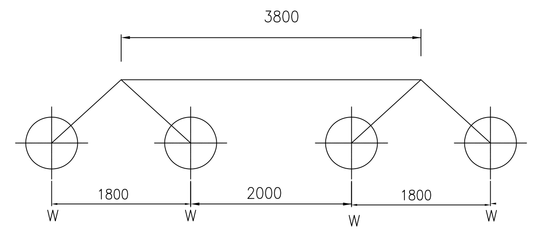
COMPUTER FILE NAME : TAL5



SL NO.	PARAMETER	VALUE
1.	DESIGN STANDARD	IS 3177 & IS 807
2.	MH HOISTING/CREEP SPEED	1.0/Ajustable from min. to max. (M/Min)
3.	AH HOISTING/CREEP SPEED	5.0/Ajustable from min. to max. (M/Min)
4.	CT SPEED/CREEP SPEED	10.0/Ajustable from min. to max. (M/Min)
5.	LT SPEED/CREEP SPEED	25.0/Ajustable from min. to max. (M/Min)



End Stopper details



MAX LT WHEEL LOAD WITHOUT IMPACT(W) = 42T

MAXIMUM LT WHEEL LOAD DIAGRAM FOR TRANSFORMER CAVERN AREA DOUBLE GIRDER CRANE

NOTES

1) DRAWING IS NOT TO THE SCALE.
2) ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METRES.
3) DIMENSIONS MARKED WITH * TO BE CONFIRMED BY SJVN LTD/CIVIL CONTRACTOR.

REFERENCE DOCUMENTS

1) DRG NO. TH-C2-AR3-C01 : POWER HOUSE COMPLEX TRANSFORMER CAVERN LAYOUT PLAN & SECTIONS
1) DRG NO. 1200-00-20-551 : POWER HOUSE GENERAL ARRANGEMENT CROSS SECTION

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY Pvt. LTD. (SAPDC)
CONSULTANT	SJVN LTD.
PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT (NEPAL) (4X225MW)

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
	DRN	RG		28/12/18
	DESN	RG		28/12/18
	CHD	PK		28/12/18
	APPD	GB		28/12/18

TITLE: CRANE CLEARANCE DIAGRAM OF TRANSFORMER CAVERN AREA FOR 100/20T DOUBLE GIRDER EOT CRANE

DEPT. | SCALE - NTS | SIGN | DATE

DRAWING NO PE-DG-437-501-A003

SHEET 1 OF 1 | REV. 0

SIZE-A2

Fold-2

ANNEXUE IX

REFERENCE DRAWINGS

-CROSS SECTION AND PLAN OF TRANSFORMER CAVERN AREA

-TRANSFORMER CAVERN –L SECTION

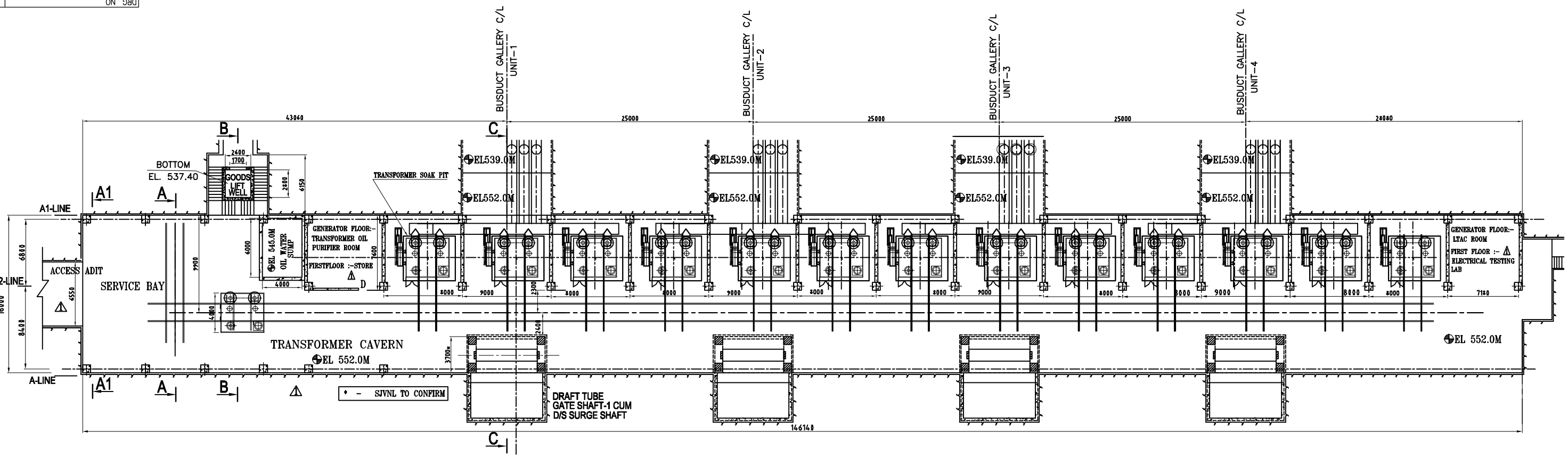
-POWER HOUSE GA PLAN AT 539.0 M

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

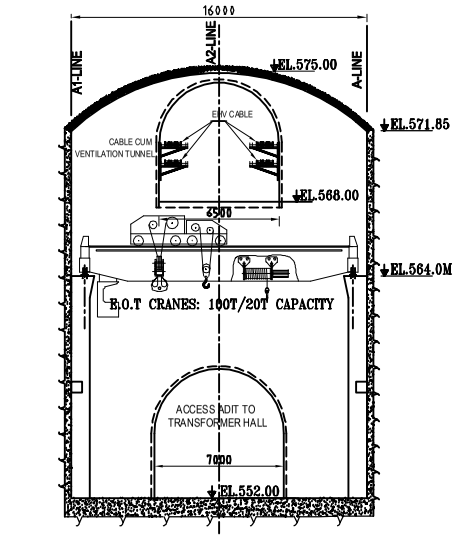
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

DRG. NO. 1 200 00 20570 REV. 02

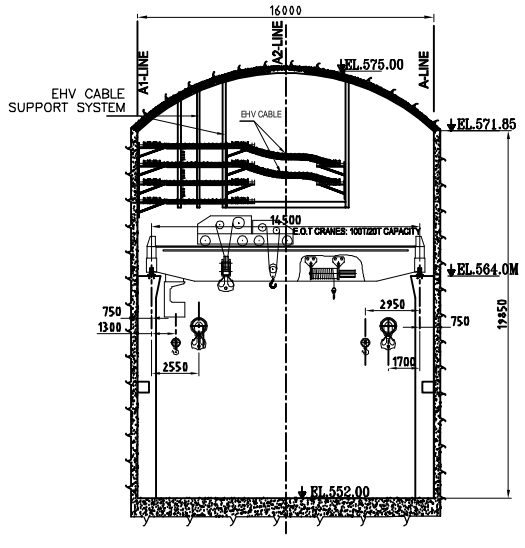


PLAN OF TRANSFORMER CAVERN AT EL 552.0M



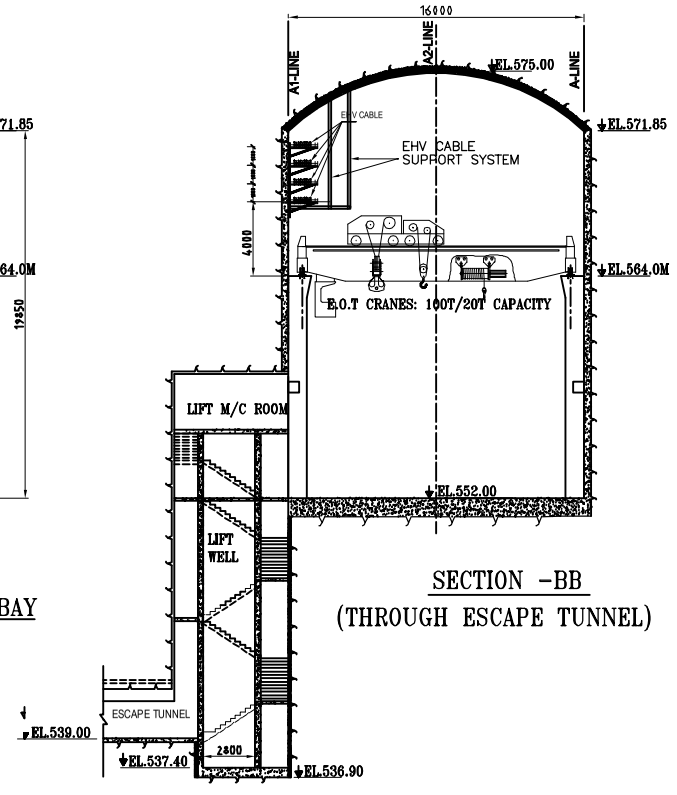
SECTION -A1A1

CROSS-SECTION THROUGH SERVICE BAY



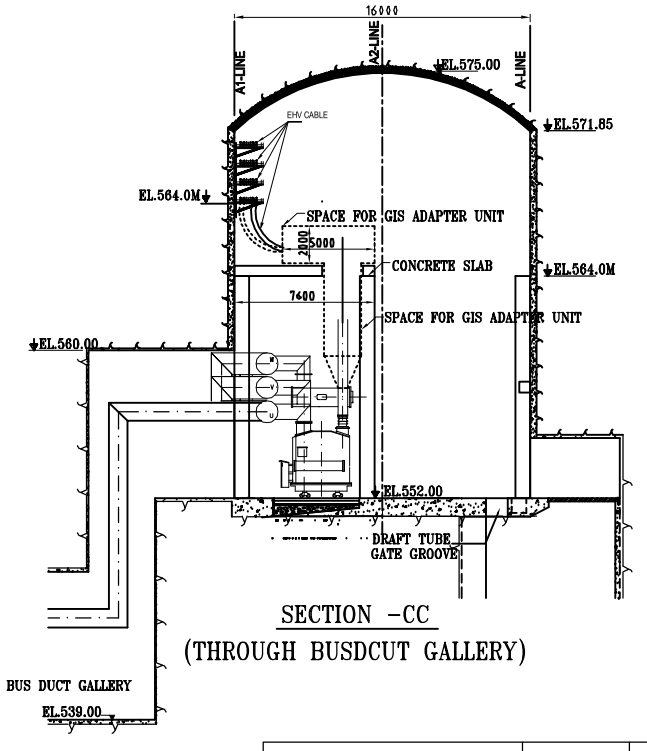
SECTION -AA

CROSS-SECTION THROUGH SERVICE BAY



SECTION -BB

(THROUGH ESCAPE TUNNEL)



SECTION -CC

(THROUGH BUSDCUT GALLERY)

- LAYOUT PLAN AT EL 564.0 M SHALL BE INCORPORATED AFTER FINALIZATION OF HV SYSTEM DRAWINGS.
- INTERFACING DETAILS BETWEEN GSU TRANSFORMER , LV & HV BUSDUCT SHALL BE INCORPORATED LATER AFTER FINALIZATION OF SYSTEM DRAWINGS.
- DETAILS OF TRANSFORMER SOAK PIT SHALL BE INCORPORATED AFTER FINALIZATION OF TRANSFOREMER DRAWING.

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE/LOCATION OF COLUMNS AND BEAM ARE TENTATIVE AND MAY BE REVIEWED BY SJVNL.

REV.	DATE	ALTERED		
		CHECKED		
		APPROVED		
ZONE				

REV.	DATE	ALTERED		
02	15.06.19	CHECKED	DK	
		APPROVED	DK	
ZONE		REVISED AS PER MOM DATED 19.04.19 (2)		

REV.	DATE	ALTERED		
01	15.03.19	CHECKED	DK	
		APPROVED	RS	
ZONE		REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED (1)		

ADDITIONAL INFORMATION		PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
STATUS OF DRAWING	U	CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
DISTRIBUTION OF PRINTS		CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
		CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.9.18	
CHKD	DK		10.9.18	
APPD	RS		10.9.18	

SUB-SUPPLIER / VENDOR

DEPT	CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSE	415			1:200				

TITLE: CROSS SECTION AND PLAN OF TRANSFORMER CAVERN

DRAWING NO. 1 200 00 20559 REV. 02

SHEET NO. 01 NO. OF SHEETS. 02

A1 SIZE

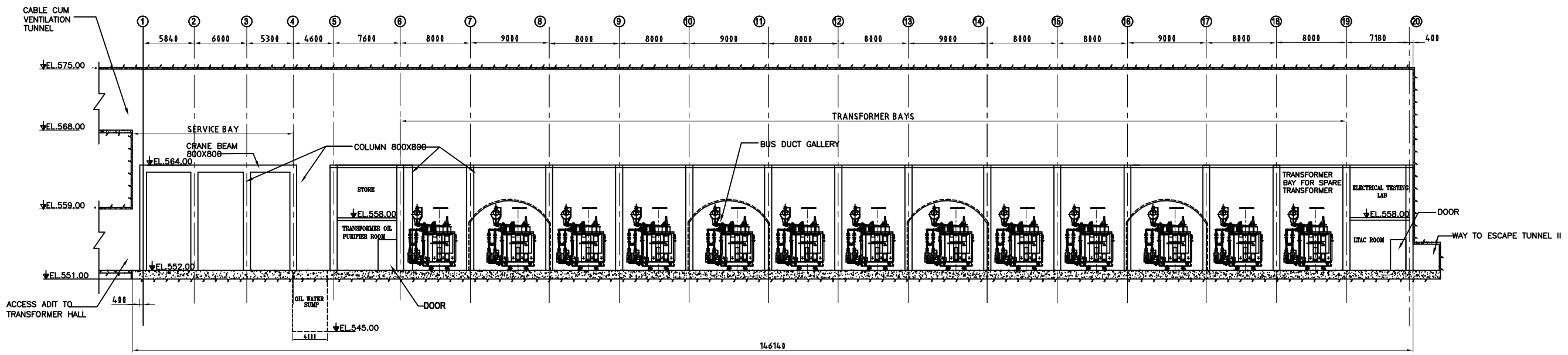
THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

INVENTORY NO. | SIGN. & DATE | REF. DRG. NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

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.



LONGITUDINAL SECTION THROUGH CENTER LINE OF TRANSFORMER CAVERN

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.

| REF. DRG. NO. | | |

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

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.

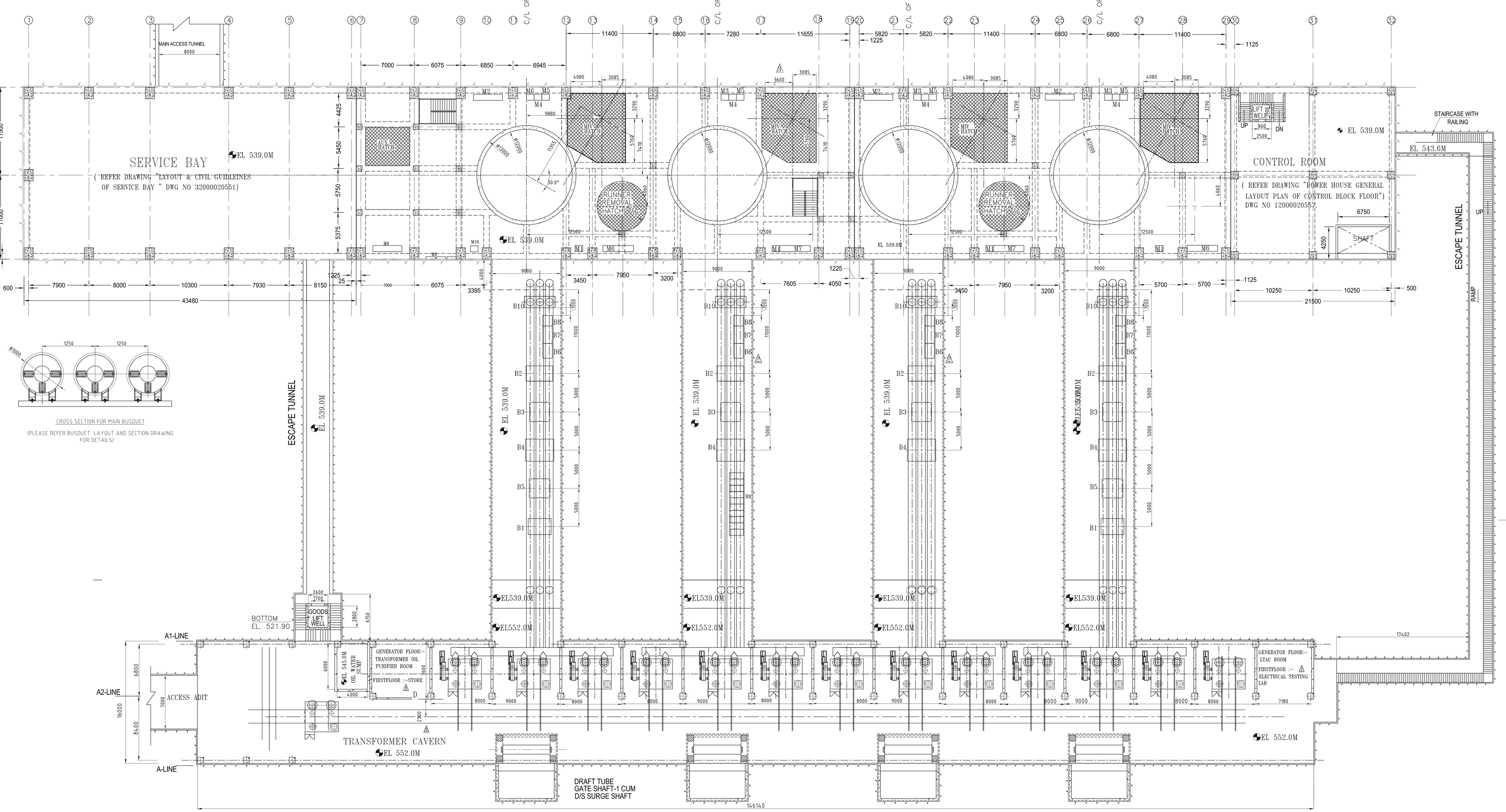


TABLE FOR DIMENSIONS OF EQUIPMENTS-MACHINE ROOM (TENTATIVE): ⚠

ITEM No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
M1	EHGC	1000	800	2415	-	1	4	EDN
M2	AUTO SEQUENCER EQUIPMENT	3804	800	2415	-	1	4	EDN
M3	GUAGE PANEL	1000	800	2415	-	1	4	EDN
M4	TEMPERATURE MEASUREMENT PANEL	1000	800	2415	-	1	4	EDN
M5	INSTRUMENT PANEL	1000	800	2415	-	1	4	EDN
M6	GENERATOR PROTECTION PANEL U-1 & 4	1000	800	2295	-	4	8	SWE
M7	GENERATOR PROTECTION PANEL U-2 & 3	1000	800	2295	-	4	8	SWE
M8	STARTER PANES FOR DRAINAGE DEWATERING & FLOOD PROTECTION PUMPS (WALL MOUNTED)	1200	325	1200	-	1	3	HPE
M9	LCB FOR STATION & COMMON AUXILIRIES	3804	800	2415	-	1	3	HPE
M10	FIRE FIGHTING PANEL	1000	800	2400	-	-	1	PESD

TABLE FOR DIMENSIONS OF EQUIPMENTS-BUS DUCT GALLERY (TENTATIVE): ⚠

ITEM No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
B1	LAVT CUBICLE	3000	2150	2500		1	4	RUDRAPUR
B2	EXCITATION TRANSFORMER	3500	2000	3150		1	4	EDN
B3	UNIT AUXILIARY TRANFORMER	2500	2600	2700		1	4	JHANSI
B4	ISOLATOR CUBICLE	2700	2500	2700		1	2	
B5	STATION AUXILIARY TRANFORMER	3700	2900	3800		1	2	JHANSI
B6	REGULATION CUBICLE	1926	1250	2465	-	1	4	EDN
B7	THYRISTOR PANEL	2301	1250	2465	-	1	4	EDN
B8	FIELD SUPPRESSION PANEL	1386	1250	3045	-	1	4	EDN
B9	11 KV SWITCHGEAR	8200	1800	2415	-	-	1	SWE
B10	SHORTING CUBICLE	4000	1500	3000	-	1	4	RUDRAPUR

PLAN AT EL.539.0M & 552.0M

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE OF EQUIPMENTS SHOWN ARE TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
03. BUSDUCT ROUTING SHOWN IN TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
04. BEAM/COLUMN TO BE SUITABLY RELOCATED TO AVOID FOULING FOR HANDLING OF EQUIPMENT.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE
03	15.03.19	CHECKED DK, APPROVED RS	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠
02	26.12.18	CHECKED DK, APPROVED RS	REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED ⚠
01	16.10.18	CHECKED DK, APPROVED RS	REVISED AS PER SJVNL'S COMMENTS DATED 21.09.18 AT PLACES MARKED ⚠

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK	10.9.18		
CHKD	DK	10.9.18		
APPD	RS	10.9.18		

ADDITIONAL INFORMATION

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

SUB-SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल — Bharat Heavy Electricals Limited, Bhopal

DEPT CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
			1:250				

TITLE: POWER HOUSE GENERAL ARGT. PLAN AT EL. 539.0 M

DRAWING NO. 1 200 00 20556 — REV. 03

SHEET NO. — NO. OF SHEETS.

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

A1 SIZE

SECTION IB

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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 EOT Crane.
e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
g) Various drawings, 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) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
j) Cable BOQ worked out based on routing of cable listing provided by the vendor for " both end equipment in vendor's scope"shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

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
b) Datasheets & quality plan for motors.
c) Technical specification for LT switchgear (LTAC)
d) Technical specification for cable and cable trays

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: DOUBLE GIRDER EOT CRANES
SCOPE OF VENDOR: SUPPLY , ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT : 4 X 225 MW ARUN-III HEP, NEPAL

S. NO	DETAILS	SCOPE SUPPLY	REMARKS
1	Isolating Switch	Vendor	ill provide one number ph suppl feeder onl and shall be located in Transformer cavern building. n other voltage level re uired ill be derived b the vendor. otor starter shall be part of crane control panel.
2	Power cables, control cables, screened control cables and any special cables	Vendor	Cable from supply feeder (MCC end) upto isolating switch shall be in Vendor scope.
3	Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).	Vendor	
4	Equipment Earthing	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 / Customer.
5	Motors	Vendor	
6	Cable glands and lugs for equipment supplied by 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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

1.0	Design ambient temperature	:	40 °C
2.0	Maximum acceptable kW rating of LV motor	:	≤200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection	:	IP54 / IP55
5.0	Cooling	:	TEFC / TETV / CACA
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: -3% to +3%) and
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal box	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class 'F', with temp rise limited to class B
8.0	Minimum voltage for starting	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply **(20KW & ABOVE)**	:	240 V, 1Φ , 50 Hz
12.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL
13.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS 12615
14.0	Additional tests	:	As per QP
15.0	Flame-proof motor		
	a) Enclosure suitable (As per IS:2148)	:	As per requirement
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
	c) Degree of protection	:	IP65
16.0	Makes	:	AS PER SUB VENDOR LIST
17.0	Terminal box	:	Suitable to rotate at 90 degrees
18.0	Paint shade	:	Shall be given during Detailed engg.
19.0	Efficiency class	:	As per IS 12615 : 2011

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

	TITLE	SPECIFICATION NO. PE-TS-437-501-A003
BHEL	LV MOTOR DATA SHEET - C	SECTION I-B REV NO. 00 DATE SHEET 1 OF 2

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

CUSTOMER SPECIFICATION FOR ELECTRICAL PART

1. CABLE AND CABLE TRAYS
2. 415 LTAC SYSTEM

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION - 18

CABLE AND CABLE TRAYS
(AS PER APPLICABILITY OF SCOPE DEFINED IN SECTION IA)

18.1 SCOPE OF WORK

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, unloading, site storage and preservation, in plant transportation at site, erection / installation, testing supervision, pre commissioning, successful commissioning, performance and acceptance testing, handing over to Employer and warrantee for two years of Cable and Cable Trays as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation. The scope of work covered under this section shall be read in conjunction with General Technical specifications, Chapter-1.

18.1.1 Detail scope of work

The scope of work shall be a comprehensive functional system complete in every respect including but not be limited to following:

18.1.1.1 Power cables

i. One(1) Lot of 11 kV, Aluminium conductor, XLPE, unarmored power cable (High voltage cable) as per SLD Drg. No. SJVN/ED/ARUN-III/EM-2015-03 (Sheet 1 to 3)

ii. One(1) Lot of 33kV, Aluminium Conductor, XLPE, unarmoredpower cable(High voltage cable) as per SLD Drg. No.SJVN/ED/ARUN-III/EM-2015-03 (Sheet 1 to 3)

iii. One(1) lot of 1.1 kV PVC/XLPE, Aluminium conductor,unarmoredpower cable (Low voltage cable)as per SLD Drg. No. SJVN/ED/ARUN-III/EM-2015-03 (Sheet 1 to 3)

iv. One (1) Lot of 1.1 kV PVC/XLPE, Copper conductor, unarmored power cable (Low voltage cable) for DC System as per DC SLD Drg. No. SJVN/ED/ARUN-III/EM-2015-10 (Sheet 1 & 2)

v. One (1) Lot of power cable, copper conductor connecting the rotor to DC field breaker.

vi. One(1) lot of power cable, Copper conductor, from DCDB to HS pumps including intermediate panels.

vii. One(1) Lot of power cables from LT boards at Power house, Switchyard,Surge Shaft, BFV house, TRT and Dam site, HRT/SFT cavern,to unit auxiliaries and station auxiliaries upto the motor/equipments including intermediate panel/junction box.

viii. One(1) Lot of power cables from LT boards at Power house, Switchyard,Surge Shaft, BFV house, TRT and Dam site, HRT/SFT cavern, to balance of plant items like LP compressor, elevator, EOT cranes, HVAC, illumination, firefighting system, workshop/laboratory etc. upto the motor/equipments including intermediate panel/junction box.

ix. One(1) Lot of power cables from EM panels to third party interface such as Hydro-mechanical equipment, PLCC equipments, civil infra equipments (ejector, water purification plant etc.) etc. at Power house, Switchyard,Surge Shaft, BFV house, TRT and Dam site, HRT/SFT cavern.

18.1.1.2 Control and instrumentation cables

i. One (1) Lot of 600/1000 Volt, Copper conductor control cables for Control System (interconnection of various control panels, field equipments, junction box etc.

ii. One (1) Lot of 600/1000 Volt, Copper conductor, Instrumentation cables for connection of various field equipments like RTDs, thermocouple etc. to control panels .

iii. One (1) lot of Coaxial and communication cables for PLCC, time synchronization etc.

iv. One(1) Lot of control cables from EM panels to third party interface such as hydro-mechanical panels

Any other power/control cable not specifically mentioned in the scope of this chapter and other chapters shall be in the scope of contractor at all places.

18.1.1.3 Cable trays and accessories

i. One (1) Lot of perforated/ladder galvanized cable trays including bends, Tees, cross connectors, reducers,hardware of various width as per requirement.

ii. One(1) lot of stainless steel cable trays including bends, Tees, cross connectors, reducers,hardware of various width as per requirement for humid areas prone to water dripping and sprays such as drainage gallery etc.

iii. One (1) lot of Supports including pre-fabricated structures/fixtures strut channels, embedment, hardware (nut, bolts) etc.

iv. One (1) lot of Cable ducts, conduits, channels, joints etc.

v. One(1) lot of Cable terminals, termination kits, cable lugs, cable glands, cable ties, cable sparebutton tape (strap and stud), and cable junction boxes and all other accessories.

vi. Two(2) nos. of automatic tagging guns/ cable marking and tagging equipment with all consumables.

vii. One (1) Lot of GI earth strip & GI wire of various sizes as per requirementfor earthing of cable trays and electrical equipments (motors, panels, marshaling box, junction box etc.) to main riser.

18.1.1.4 Control, monitoring and related items and services

Co-ordination and provision of necessary contacts and/or ports for integration with plant SCADA system.

18.1.1.5 Common Supplies and services

i. Fifteen (15) sets of handsets and chargers for two way communication system including necessary license from the statutory body /concerned Deptt. of GON
ii. Drawings, documents and design calculations as per clause 18.6.
iii. Shop, assembly, inspection & tests as per clause no. 18.7.
iv. Packaging, handling and site storage as per clause no. 18.8.
v. Delivery, installation and commissioning as per clause no. 18.9.
vi. Tools and instruments as per clause no. 18.10.
vii. Spare parts as per clause no. 18.11
viii. Field/touch-up painting including all painting materials.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

18.1.1.6 Completeness of System

Any other item (s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard (s)/best international practice.

18.2 STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

18.3 CABLE PARAMETERS& GUARANTEES

18.3.1 General

All cables shall be designed to cope with:

- The short–circuit conditions,
- The applied protective system in respect to cross-section and number of cores.

The cables shall be capable of satisfactory operation under a power supply system voltage variation of 10% and frequency variation of 5% and a combined frequency voltage variation of 10% (absolute sum). The cables shall have heat and moisture resistant properties. These shall be of type and design, with proven record of hydro power station installation.

18.3.2 Rating and Functional Characteristics

18.3.2.1 Power cables –33kV &11kV system single/multi-core cables

33kV &11kV power cable shall be of heavy duty, stranded circular aluminium conductor, cross linked polyethylene (XLPE) insulated provided with conductor screening and insulation screening, laid up, extruded PVC inter sheathed, unarmored conforming to relevant IEC/IS. The semi-conducting tape and extrusion of semi-conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material. The insulation and screening shall be extruded, semi-conducting and with copper tape screening (with at least 0.075 mm thickness) about it.

The cable shall have the following properties:

- Oxygen index — Min. 29,
- Smoke density — Min. 40% light transmittance,
- Acid gas — Max. 20% by weight,
- Flame propagation — As per relevant IEC

18.3.2.2 Power cables -1100 volt grade

I. Single core cables

These cables shall be at least 1100 volt grade, heavy duty, single core, stranded Aluminium / Copper conductor, FRLS, HR-PVC/XLPE, insulated and PVC sheathed, unarmored and shall conform to the same design and properties as cables conforming torelevantIS/IEC.

II. Multi core cables:

The cable shall be at least 1100 volt grade, heavy duty multi core, stranded Aluminium/Copper conductor, FRLS, HR-PVC/XLPE insulated, color coded, laid up, unarmored, inner sheathed with extruded PVC, 2/3.5 cores, conforming to relevant IS/IEC.

18.3.2.3 Control and instrumentation cables

The control and instrumentation cables shall be multi core, colour coded, unarmored, annealed stranded high conductivity Copper, single conductor, insulated with HR-PVC insulation, PVC sheathed and armoured, conforming to relevant IS/ IEC.

18.3.2.4 Coaxial cable

Coaxial cable shall be offered in accordance with relevant IEC/ISto connect coupling unit installed in the pothead yard to the PLCC terminals, installed in control room of

powerhouse. The cable offered by the Contractor shall be steel armored. The cable shall have braided tinned Copper conductor. The capacitance of the cable shall be low so as to minimize attenuation in the carrier frequency range. The impedance of the cable shall be so as to match with the output impedance of the PLC terminals and secondary impedance of the coupling units. The cable shall be insulated to withstand a test voltage of 4 kV .The Contractor shall supply H.F. cable with following properties:

- Co-axial H.F. cable with 75 ohms characteristic impedance (unbalanced),
- Capacitance per meter – 53-pf approx.,
- Test voltage in kV – 4 kV RMS for 1 minute,
- Size of conductor – 7 strands/0.4mm.

The maximum attenuation at various frequencies shall be as follows:

Frequency in KHZ	Attenuation in db/km
300	1.4
60	3.3
500	4.7

18.3.3 Performance Criteria and Guarantee

The power, control, instrumentation, coaxial communication and other cables along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

18.4 DESIGN AND CONSTRUCTION

18.4.1 Conductor material

All DC,control and instrumentation cables shall be of copper conductor. Power cables shall be of aluminium or copper conductor as defined in the scope.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

18.4.2 Conductor shield

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).

18.4.3 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. This should be in accordance with relevant IS and IEC standards.

18.4.4 Insulation shield

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 and power cables and special cables shall be provided

18.4.5 Sheath

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. This should be in accordance with relevant IS and IEC standards.

18.4.6 Service and outer sheath

Extruded PVC servingas specified shall be applied with suitable additives to prevent attack by rodents and termites. All servings must be given anti-termite treatment. The cable should also offer a specially formulated Flame Retardant Low Smoke compound (FRLS) for outer sheath**h**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 temperature of the insulation and compatible with the insulation.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

18.4.7 Size and length of cables

The number of cores and sizes of the cables required for various circuits shall be worked out during detailed engineering.

However, minimum sizes for the following cables conductor shall be taken as:

- 2.5 mm^2 copper for control cable conductor,
- 1.5 mm^2 copper for annunciation and RTD cable conductor,
- 4 core x 6 mm^2 copper for connection between CT junction boxes and panels having red, yellow, blue and black colour cover,
- 4 core x 4 mm^2 copper for connection between PT junction boxes and panels having red, yellow, blue and black colour cover.

The cables covered by this specification shall be supplied in one length or in standard length as approved by the Employer.

18.5 AUXILIARY SYSTEMS AND MISCELLANEOUS COMPONENTS

18.5.1 Color scheme and identification

To facilitate easy identification of phases a color scheme of red, yellow and blue for phases and black for neutral shall be adopted for power cables. Multi-core control cables shall be color coded for identification of cores as per relevant IS/ IEC.

All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least three (3) meter run. The manufacturer's data shall include the name, cable size, and voltage rating together with any other information.

18.5.2 Termination kit

The termination kits required for 11kV& 33kV XLPE cables terminations shall be heat shrinkable type as per relevant IS/IEC.

The Contractor shall supply all hardware consumables such as plumbing metal, sealing compound, tapes and other materials required for the making of these terminal

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

connections of various sizes of cables and should handover the consumables equivalent for two connectionsto the Employer.

18.5.3 Cable lugs

The Contractor shall ensure that no bimetallic action takes place, between the conductor of the cable and the cable-connecting lug by filling the lugs with suitable compound. The lugs shall be of standard quality conforming IEC / IS.

18.5.4 Cable accessories

The Contractor shall supply all the required accessories that may be found necessary during actual execution of the job and cost of them shall be included in the contract price. No intermediate joint will be allowed in the run of any cable.

18.5.5 Cable glands

The cable glands shall be made of brass duly electro tinned in order to avoid corrosion and oxidation of the surface. The nipple threads shall be in accordance with relevant IS/IEC. Glands shall provide neat, tight, dust and vermin proof termination. Gland shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Gland shall be complete with suitable washers etc.

18.5.6 Compression type terminals for control wiring

These terminals are required for copper conductor of control wiring. They shall be crimped to the conductor while other end will provide flat surface for better connections. The connectors shall be made of Copper electro tinned.

18.5.7 Button tape (strap and stud)

This consists of perforated cable strapping with holes conveniently spaced for assembly and moulded studs. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

18.5.8 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 special formulated ink with specific thermo-setting adhesive to withstand high temperature.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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 cable schedule such that each core of each cable can be identified easily.

18.5.9 Aluminum strip

Aluminium strip of adequate size for making tags for labels shall be supplied.

PVC tapes, cotton tapes and any other accessory required for laying, termination, testing and commissioning shall be supplied of good quality as per relevant Indian Standards.

18.5.10 Cable trays and support structure

Perforated cable trays made out of 14-gauge mild steel sheet shall be fabricated. The trays shall be of perforated plates with long shape slots for proper ventilation of the cables. The trays shall have minimum 50 mm edge height.

The cable trays shall be fully galvanized as per the relevant IS / IEC

Stainless steel cable trays shall be provided for humid premises and the area prone to water dripping and spraysuch as Drainage and Dewatering and shall be finalized during detailed engineering.

Supports and screws and bolts for cable trays shall be made of the same materials as the cable trays they support.

Tray support system shall be pre-fabricated and bolted type for quick and easy installation.

Trays provided in tiers shall have minimum 300 mm spacing between tiers.

Detailed design of the cable trays and supports shall be approved by the Employer before commencement of fabrication/assembly. The fixing of supports to the walls/ceiling/tunnel/column/ trench etc. is also covered in the scope of supply. Strut channels shall be embedded for fixing of the supports and shall be provided, installed and supervised during concreting for correctness of positioning and alignment by the

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

Contractor. Anchor fasteners shall be used wherever required to fix the anchors/supports.

In addition to this, ladder type tray with double bends may be used wherever requiredconforming to relevant IEC/IS which shall be finalized during detail engineering. Also, various cable tray accessories such as vertical elbow, horizontal elbow, reducer, horizontal tee, and horizontal cross should be used.

18.5.11 Fire proofing

Cables passing through different fire zones shall be provided with fireproof barriers with the same fire rating as the penetrated walls or partitions.

18.5.12 Cable junction boxes

Junction box shall be constructed of sheet steel of thickness not less than two (2) mm. The door shall be adequately strengthened to ensure rigidity and strength. Sheet steel and sections used in enclosures shall be cut neatly and finished free from burrs. Ample wiring space shall be provided at the sides, and back of the enclosure for incoming and outgoing circuits.

Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be provided with suitable gasket and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins.

Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness.

18.5.13 Terminal blocks

As per GTS clause 1.8.5 .

18.5.14 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 could be easily identified.

18.5.15 Cable binding/strapping

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

All control cables after glanding shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel shall be such that it gives a neat appearance good workmanship.

For L.T. Power cables, suitable holding clamps will be provided in the panel if required.

The Contractor shall do the cable glanding suitable for each cable size at both ends of termination of each cable.

18.5.16 Cable routing

For the main cableways, a system of cable racks and trays as well as cable ducts and trenches shall be provided.

18.6 DRAWINGS, DOCUMENTS AND DESIGN CALCULATIONS

18.6.1 Drawings and documents

After award of contract, the contractor shall furnish all drawings, documents, design calculations, data, manuals & other necessary literature, pertaining to equipment offered by them & so specified under various clauses, in accordance with requirements stipulated in "clause 1.19 of Section – 1 i.e. General Technical Specification (GTS)". A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand for approval of the purchaser as already explained in clause no. 1.19.6 of Section – 1 (GTS). The list of drawings & documents to be furnished for approval / reference shall not be limited to the following:-

i) Drawings, documents, design calculations literatures, manuals etc. as per clause no. 1.19 of Section-1 (GTS)

ii) Drawings, documents, design calculations, literatures, manuals as listed in Annexure – D of Section -1 (GTS) referred under clause no. 1.19.6

iii) Detailed quality assurance plan, giving complete specifications of the materials and specifications relating to inspection and testing of materials and finished components.

iv) All drawings having bearing on civil foundations, equipments foundation details and loads

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

v) Arrangement, installation, foundation, plan, section, detailing of main equipment and sub-assemblies including control & instrumentation system.

vi) All Electrical& Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of this section.

vii) All manufacturing drawings not specifically covered under approval/reference category shall be submitted for record and facilitate inspection of the component in the shop and assembly at site.

viii) Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work.

18.7 SHOP ASSEMBLY, INSPECTION AND TESTS

18.7.1 Type Test

Type tests which shall fall under Category –I(refer clause 14 of GTS) are to be conducted as per Schedule VI to demonstrate that the cables and accessories offered meet the requirement of specifications.

18.7.2 Routine Tests

The following Routine tests shall be conducted on samples of manufactured cables and on components of accessories in order to verify that the finished products meet the requirements of specifications.

- Conductor resistance test,
- Partial discharge test (for screened cables),
- High voltage test.

In addition to above tests, all other tests mentioned in the relevant IS shall also be performed.
XLPE/PVC/instrumentation cable/coaxial cable shall be tested as per relevant IEC/IS standard.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

18.7.3 **Field tests**

Before commissioning of complete system, all cabling system shall be checked as per cable schedule and complete report shall be prepared by Contractor and shall be submitted.

Field test shall include:

- Continuity checking,
- IR testing
- Verification of phase order in power cables
- Visual checking in respect of tagging, laying, dressing, glanding, earthing of complete cable system.

18.7.4 Performance testing

If nothing unusual has been observed in load run and load rejection tests, the test service period of 72 hours shall follow. During this test service period, the unit must operate continuously at rated condition without any interruption except of those beyond the control of the Contractor. However, such interrupted period shall not be counted for in the test service period. There should be one month reliability run of the complete unit reckoned from the date of taking over by employer.

18.8 PACKAGING, HANDLING AND SITE STORAGE

The Contractor shall pack all the consignment in sea worthy packaging strong enough to withstand rough handling during transit. Machine surface shall be suitably protected against scratches, corrosion, shocks, impact etc. Packages shall be suitably and distinctly identified for type of handling and kind of storage.

All the cables shall be supplied on non-returnable wooden drums with adequate barrel diameter so as to avoid any damage to the cables and to withstand rough handling during transportation and storage. The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

A layer of waterproof paper shall be applied to the surface of the drums and over the outer cable layer. A circular space of at least 40mm shall be left between the cable and the lagging. Each drum shall carry the name of the manufacturer, the name of the Employer, his address, order number, item number, type, size length of cable, net and gross weight duly stenciled thereon. The supplier shall indicate the methods of

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

storage of cable drums and accessories at site during the detailed design stage.

18.9 SITE INSTALLATION AND COMMISSIONING

18.9.4 Installation procedure

The Contractor shall follow the construction methodology and installation procedure recommended by the cable manufacturer and shall arrange all the necessary erection tools/devices required for installation of cables such as cable rollers, cable pullers, motorized winches, power packs, two-way communications and safety devices etc., as per manufacturer's standard practices for installation of the cables.

Plugging of all cable gland holes left out in the panel after completion of cabling shall be done.

18.10 TOOLS AND INSTRUMENTS

18.10.1 Tools for erection and Installation.

The Contractor shall bring his own tools, devices, testing instruments / equipments to site in order to erect and install the complete equipment delivered under this section. These shall remain the property of the Contractor unless otherwise agreed to take over any / all of these at mutually agreed conditions.

18.10.2 Instruments for testing & commissioning

The list of instruments to be supplied shall be as per Schedule V(A). General requirement of these tools are as below:-

1. The contractor shall provide the highest model of the mentioned make or equivalent.
2. The timeframe to be reckoned the highest model of the mentioned make / equivalent shall be six months prior to the submission of drawings / documents for review / approval of equipment. .
3. The contractor shall submit the duly signed certificate by OEM / dealer certifying that the selected model is the highest model meeting the above timeframe criteria.
4. Supplied equipment's authorized service center shall preferably in India / Nepal.
5. Data sheet needs to be approved during detailed engineering of the finalized model selected from the list of makes. If the contractor proposes to supply the model / make equivalent to the specified list, then data sheet of the

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

equivalent make along with the data sheet of one of the makes in the list shall be submitted during detailed engineering.

6. The instruments shall be supplied at site before the starting of the testing and commissioning of 1st unit. The contractor may also use the above instruments for testing and commissioning. However, the liability for healthiness, maintenance, consumables etc. shall be in the scope of contractor during this period.
7. The instruments used for testing & commissioning shall be handed over to employer after the final COD of last unit in healthy condition (free from defects and damage). Further, contractor shall ensure the validity of Calibration certificate (as applicable)for at least one year from handing over.
8. Defect liability of tools / instruments used by contractor during testing & commissioning shall commence from the date of handing over & acceptance by the employer.
9. The other instruments shall also be handed over after COD of the last unit along with validity of Calibration certificate (as applicable)for at least one year. The defect liability period will commence from the date of handing over.
10. In case of repetition of tools / instruments in other chapters in addition to the mentioned list, those shall also be part of the scope of supply of contractor.
11. Contractor shall submit product catalogue, brochures, and routine / acceptance tests (if any), guarantee certificate, calibration certificate, instruction manual, O&M manual etc. of each and every instrument.
12. Instruments covered under this schedule shall also be governed by the vendor selection clause no. 1.12 of GTS.

18.11 SPARE PARTS

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

18.11.1 Mandatory Spare Parts

The Contractor shall supply the mandatory spare parts as per schedule-III.

18.11.2 Recommended Spare Parts

The Contractor shall furnish the list of recommended spare partsat schedule-IV.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION-20

415 LTAC SYSTEM
(AS PER APPLICABILITY OF SCOPE DEFINED IN SECTION IA)

20.1 SCOPE OF WORK

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, unloading, site storage and preservation, in plant transportation at site, erection / installation, testing supervision, pre commissioning, successful commissioning, performance and acceptance testing, handing over to purchaser and warrantee for two years of 415 V switchgear as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation. The scope of work covered under this section shall be read in conjunction with General Technical specifications, Chapter-1.

20.1.1 Detailed Scope of Work

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

20.1.1.1 415 V Switchgear

3-phase, 50 HZ, 415 V switchgear systems consisting of following major items:

i. Four (4) sets of unit auxiliary boards (UABs) of minimum 1000A, 25kA rating having Cu bus bar with 2 nos. Incomer ACBs.
ii. One (1) set of sectionalized station service board (SSBs) of minimum 4000 A, 63kA rating having Cu bus bar with 4 Incomer ACBs.
iii. One (1) set of sectionalized Distribution boards of minimum 1000A, 25kA rating having Cu bus bar with 3 no Incomer ACBs at Dam & Intake loads.
iv. Five (5) sets of Distribution boards of minimum 630A, 12.5kA rating having Cu bus bar with 2 no Incomer ACBs at Transformer Hall, surge shaft , Pothead yard , PPV house, TRT outfall

20.1.1.2 Sandwich bus duct for the following interconnection as per tender drawings enclosed:-

i) Between UAT and UAB

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

ii) Between SST and SSB

iii) Between UAB and SSB

20.1.1.3 Control, monitoring and related items and services

Co-ordination and provision of necessary contacts and/or ports for integration with plant SCADA system.

20.1.1.4 Common Supplies and services

i. A suitable trolley mounted earthing device shall be provided which, when in circuit, earths the bus bars of feeder side of the breaker.
ii. Drawings, documents and design calculations as per clause 20.6.
iii. Shop, assembly, inspection & tests as per clause no. 20.7.
iv. Packaging, handling and site storage as per clause no. 20.8.
v. Delivery, installation and commissioning as per clause no. 20.9.
vi. Tools and instruments as per clause no. 20.10.
vii. Spare parts as per clause no. 20.11
viii. Field/touch-up painting including all painting materials.

20.1.1.5 Completeness of System

Any other item (s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard (s)/best international practice.

Notes:

i) All the above sets of boards shall be of indoor metal enclosed 415 V switchgear type, complete with cubicles, Circuit breakers , protection, relays metering instruments, bus-bar system, support insulators, cabling, internal wiring and other accessories, to complete the scope as per Singe Line Diagram No SJVN/ARUN III/EM-2017-02 & SJVN/ARUN III/EM-2017-03 & detailed in the specifications.

20.2 STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

20.3 PARAMETERS & GUARANTEES

20.3.1 Scheme

The switchgear system is solidly grounded, 3 phases with Neutral (TPN). The voltage level envisaged for Dam will be at two voltage levels i.e. 33KV & 0.415KV and for Power House & Switchyard it will have three voltage levels i.e. 33KV, 11KV and 0.415KV for MV/LV supply scheme.

Unit auxiliaries will be fed from the 630 KVA 15.75kV/415V, UAB/UAT (Unit Auxiliary Board/Unit Auxiliary Transformer) tapped from the bus duct.

Two (02) 15.75/11 kV, 5 MVA SATs will be installed in power house, one on unit -1 generator transformer LV terminals, the other on unit -4 generator transformer LV terminals, by providing a disconnector between generator and generator transformer.

Station auxiliaries will be fed from the 2.5 MVA 11kV/415V, SSBs/SSTs (station service Board/station service Transformer).

Initially when the generating unit is standstill, the power requirement of unit auxiliary board UAB(1-4) shall be met from SSBs. The SSBs are fed following two sources:

1) Two (02) station service transformers (SSTs) being fed from two separate direct feeders from SATs connected through 11 kV Switchgear.

2) Two (02) 415 V,1MVA DG sets will be installed at 400KV switchyard

The units shall be started one at time. After the unit is synchronized the auxiliary power requirement of the generating unit shall be met by the unit auxiliary transformer(UAT).

3 phase, 415 V Distribution boards shall be provided to meet the power requirements of Transformer hall, TRT, Pothead yard, PPV& Surge shaft.

To cater the needs of DAM site, 3 phase, 415 V Distribution boards shall be provided at DAM site.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

It shall be the responsibility of the Contractor to complete the work in all respect and to make the scheme functional as per Singe Line Diagram No SJVN/ARUN III/EM-2017-02 & SJVN/ARUN III/EM-2017-03

20.3.2 Rating

A	**Common**	
1.	Location	Indoor
2.	No. of bus bars, 3-phase	1
3.	Rated voltage , V	415
4.	Rated frequency, Hz	50, -5% to +3%
7.	Protection class	IP42
8.	Rated power frequency withstand voltage 60s for main circuits	2kV
9.	Rated power frequency withstand voltage 60s for control circuits	2000 V
10.	Control voltage, DC	200 +10 % / -20%V
11.	Auxiliary AC supply, 3 phase	415 ± 10 %
	Current ratio of CTs	As per SLD
12	Accuracy of CT	
	For O/C and E/F	5P10
	For REF	PS
`	For metering	0.2
B	**UAB**	
1.	Rated current of Bus bar & ACBs, A	1000
	Short circuit current rating for 1 sec	25 kA
2.	Material of Bus bar	Copper
C	**SSB**	
1.	Rated current of Bus bar & ACBs, A	4000
	Short circuit current rating for 1 sec	63 kA
2.	Material of Bus bar	Copper
D	**Transformer hall/Pothead yard/TRT / PPV / surge shaft/ Dam site**	
1.	Rated current of Bus bar & ACBs, A	630
	Short circuit current rating for 1 sec	12.5 kA

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

2.	Material of Bus bar	Copper
E	**Dam & Intake loads**	
1.	Rated current of Bus bar & ACBs, A	1000
2.	Short circuit current rating for 1 sec	25 kA
3.	Material of Bus bar	Copper
F	**Connections**	
1.	B/w SST & SSB	Sandwich Bus duct
2.	B/W UAT & UAB	Sandwich Bus duct
3.	B/W SSB & UAB	Sandwich Bus duct

20.3.3 Performance Guarantee

The 415 V switchgear along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

20.3.4 Current ratings and short circuit capabilities

The current ratings/ CT/PT ratings mentioned above & in the SLD are indicative only. However, the rated continuous current of any circuit connection or component shall correspond to the maximum current for which that connection or component is designed to carry continuously during operation, under the most unfavorable service conditions which shall be finalized during detailed engineering.

20.3.5 Temperature Rise

The A.C. distribution boards shall be designed to operate satisfactorily under the site conditions and the maximum temperature attained by any part of the equipment wherein service at an ambient temperature of 40 & - 5 deg.C. shall not exceed the limits specified corrected for the site conditions.

20.4 DESIGN AND CONSTRUCTION

20.4.1 AC Distribution Boards

20.4.1.1 General

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The 415 V switchgear shall be metal enclosed indoor cubicles free floor standing type.

All Distribution Board frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2 mm. Frames shall be enclosed in cold rolled sheet steel of thickness not less than 1.6mm. Doors and covers shall also be of cold-rolled sheet steel of thickness not less than 1.6mm. Stiffeners shall be provided wherever necessary.

All Distribution Boards shall be of dust, vermin proof construction and shall be provided with a degree of protection of IP-52.

Hinged doors and removable covers shall be provided wherever necessary to allow access to all equipment. The frame of the cubicles shall be sufficiently sturdy and the metal sheeting of sufficient thickness to ensure safe transport, mounting and operation without deformation or bulging. Natural ventilation as required shall be provided. Distribution Boards shall be easily extendable on both sides, by the addition of the vertical sections after removing the end covers.

The AC distribution board cubicles should comply with the requirement of relevant Indian Standard and Indian Electricity Rules for providing minimum clearance between phases of the bus and live parts from metallic parts.

Continuous lifting hooks shall be provided to facilitate the installation of the transportable cubicles. All identical circuit breakers and module chassis of same size shall be fully interchangeable without having to carryout modifications.

Adopter panels and dummy panels required to meet the various bus bar arrangements and layouts required shall be included in tenderer's scope of work. All sheet work shall be pretreated, in tanks, in accordance with relevant IS.

20.4.1.2 Compartments

Each cubicle shall be divided into sections, or compartments, housing the incoming, interconnecting or outgoing feeder air circuit breaker units and moulded case circuit breaker units respectively.

After isolation of power and control circuits connections it shall be possible to safely carryout maintenance in a compartment with

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

the bus bar and adjacent circuits live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.

Each ACB and MCCB unit shall be mounted on a carriage assembly, constructed so that the unit can be removed and replaced while the buses are energized. The carriage shall have self-engaging definite position stops for disconnected, test and connected positions. All necessary means shall be provided for easy removal and handling of the unit.

20.4.1.3 Cable compartments

All feeders to and from the cubicle assemblies will be cables except from UAT to UAB, SST to SSBs and SSB to UAB. The assemblies shall be accessible for the cables from bottom to each feeder circuit breaker via separate cable compartment. Solder less connectors shall be furnished for each power conductor entering the equipment. Provisions shall be made to clamp and fasten cables in the cable. Compartment. Terminals for cable connection will be suitable for Aluminium cables.

20.4.1.4 Derating of Equipments

The current ratings of all equipments as specified in rating clause are the minimum standards current ratings at a reference ambient temperature of 40 deg.C as per relevant Indian Standards.

The Bidder shall indicate clearly the de-rating factors employed for each component and furnish the basis for arriving at these de-rating factors duly considering the specified ambient temperature.

20.4.1.5 Name plates

Each feeder shall be clearly identified with suitably located nameplate(s). Nameplates shall be furnished for all instruments, control switches, etc. Each section of an assembly shall have an identifying name plate placed near the top edge.

20.4.1.6 Wiring

All secondary and control wiring shall be done with stranded copper wires, current transformer secondary leads shall not be less than 4.0

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

mm2. All control wiring within the assembly housing shall be installed at the manufacturer's premises.

All connections shall be made with solder less lugs. All wires and connections to remote equipment shall be wired to terminal blocks.

20.4.1.7 Bus bars

Bus bar conductors shall be made of copper. All connections shall be in accordance with the best modern practice.

The 415 volts copper bus bars shall be rectangular in cross section so as to be able to carry the required current within the limits of temperature rise at the site conditions. and connection of ample size shall be brought to each feeder compartment, for bolted connection of the feeder.

Phase arrangements shall be R-Y-B from top to bottom, from back to front and from left to right when facing the front of the equipment.

All bus bars shall be clearly marked by engraved letters.

Adequate provisions must be made for the expansion and contraction of the bus bars and other bus bar connections with variation in temperature. Bus bars shall be so arranged that they can be extended in length without difficulty. All bus bars shall be adequately supported by Non-hygroscopic, non-combustible, track-resistant and high strength type Polyester fibre glass Moulded Insulators/Epoxy Insulators. Separate supports shall be provided for each phase and neutral bus bar. If a common support is provided anti-tracking barriers shall be provided between the supports.

All field connections shall be bolted. The connections shall be kept as short and straight as possible. Bus bars, connections and their insulating supports shall be of approved construction, mechanically strong and shall withstand all the stresses, which may be imposed upon them under ordinary working conditions due to vibration, temperature fluctuations, short circuit or other reasonable causes. Auxiliary buses shall be provided for AC and DC Control power supplies. The material for all auxiliary buses for Control power supplies shall also be of high electrolyte copper.

20.4.1.8 Earth Bus

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

A galvanized steel earthing bus shall be provided at the bottom of each panel and shall extend throughout the length of each distribution board & protruded at the extreme ends suitably for connection with the earthing grid. It shall be bolted to the frame work of each panel and breaker earthing contact point, vertical earth bus shall be provided in each vertical section which shall in turn be bolted to main horizontal ground bus.

The earth bus shall have sufficient cross-section but not less than **size 25x5mm** thick to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise. However the **calculations** for arriving at the size of the earth bus shall be furnished with the bid.

All non-current carrying metal work of the distribution board shall be effectively bonded to the earth bus. Electrical conductivity of the whole distribution enclosures frame work and the truck shall be maintained even after painting.

All metallic cases of relays, instruments and other panel mounted equipments shall be connected to earth bus by independent stranded copper wires of size **not less than 2.5 mm.sq.**

VT and CT secondary neutral point earthing shall be at one place only i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

All hinged doors shall be earthed through flexible earthing braid.

20.4.1.9 Instruments

Control switches and instruments shall be mounted on the circuit breaker compartment doors / front side of the panel.

20.4.2 Air circuit breakers

20.4.2.1 General

The circuit breaker shall be triple pole, horizontal draw out type.

Circuit breakers shall be mounted along with its operating mechanism on telescopic rails. The cradle should be designed and constructed so as to permit

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

the smooth withdrawal and insertion of the breaker into it. The movement should be free of jerks and shall preferably be on rollers and not on the flat surface. Suitable guides shall be provided to minimize misalignment of the breaker.

There shall be service, test, isolated and maintenance positions for the breakers. All the three poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.

The main contacts should be of appropriate silver alloys. Mere silver plating of the faces shall not be acceptable.

Arcing contacts should be of tungsten base alloy and mere silver plating of the faces shall not be acceptable. Arcing contacts must be separate from main contacts and one piece butt type contacts shall not be acceptable.

The ACB cubicle shall have door interlocking facility so that the cubicle door cannot be opened when the ACB is closed or in "Test" position. Inbuilt interlock should be provided to prevent the closed circuit breaker being inserted into the panel.

The ACB shall have provision of locking it in isolated position for keeping personnel and equipment safe during maintenance.

Automatic safety shutters shall be provided to ensure that the cradle terminals are completely covered when the circuit breaker is drawn out. Complete removal of the breaker from the distribution board shall be simple and smooth. When the cubicle door is closed, the breaker shall be able to achieve three different positions "SERVICE/ISOLATED/TEST POSITION". When the cubicle door is open, the breaker should be capable of achieving "MAINTENANCE" position where free access is obtained to all parts of the breakers.

An auxiliary switch with 12 NO and 12 NC contacts shall be provided with each breaker and wired up to terminal block.

A suitable trolley mounted earthing device shall be provided which, when in circuit, earths the bus bars of feeder side of the breaker.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

20.4.2.2 Power Operated Mechanism

Circuit breaker shall be provided with **motor operated spring** charged mechanism. The motor shall be a universal motor suitable for operation from 240 ±10%V AC.

The charging time for closing springs shall not be more than 30 seconds.

After failure of power supply, at least one **open-close-open** operation shall be possible.

Provision shall be made for emergency manual charging of closing spring.

Circuit breakers shall be provided with closing and tripping coils. The closing coil shall operate correctly for voltage variation between 85% to 110% and trip coil for voltage variation between 70% to 110%.

Mechanical tripping shall be possible by means of front mounted red coloured trip push button. These push buttons shall be shrouded to prevent accidental operation.

Circuit breaker shall be provided with mechanical indicating devices to show OPEN, CLOSE, TEST and SPRING CHARGED conditions.

Circuit breaker shall be provided with no voltage release as it may be necessary to fulfill operation logic requirement.

Provision shall be made to lock the breaker in "Isolated" position.

Interlocking of the incomer ACB's with the other associated tie ACB's shall also be provided as per the operation logic to be decided during detail engineering stage. In case sufficient number of auxiliary contacts are not available, auxiliary **relay** shall be provided for interlocking.

20.4.3 Moulded Case Circuit Breakers (MCCB)

All the outgoing feeders (except where specifically mentioned) shall be provided with Molded Case Circuit Breakers (MCCB's) having suitably designed for thermal over load and magnetic short circuit protection.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The MCCB's shall be mounted in a trolley which shall be of draw out type. The draw out mechanism for MCCB's shall be such that it shall be held in the cradle made of welded steel by means of two telescopic rails on which it shall be supported. These rails shall slide over ball bearings which shall make the movement of the MCCB's on the cradle extremely smooth.

MCCB's shall be manually operated. The operating handle should give a clear trip indication.

Alarm Scheme - Audible and visual (Mechanical flag indication) alarm scheme suitable for operation from 220V DC supply shall be provided to indicate tripping of ACB and MCCBs.

The MCCB's shall be quick make/quick break, trip free and independent of manual speed for operation.

MCCB's shall be fitted with direct acting magnetic thermal release for short circuit and overload protections. Settings of the thermal release shall be independently adjustable over a wide percentage range of nominal rating in all ranges.

The ratings of the MCCBs shall be finalized during detail engineering stage.

20.5 AUXILIARY SYSTEM AND MISCELLANEOUS COMPONENTS

20.5.1 Refer cl. no. 1.8 of GTS for Instrument Transformers, metering instruments, control and selection switches, push buttons, indicating lamps, HRC fuses, terminal blocks, name plates and labels, space heaters, control & secondary wiring etc.

20.5.2 **415V AC/Copper Sandwich Type Bus Duct And Power Cables Terminations**

LT, sandwich type TPN copper bus-ducts of adequate size and enclosure of non-magnetic aluminum material with shall be provided:

i. B/w SST & SSB
ii. B/W UAT & UAB
iii. B/W SSB & UAB

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

The length of the AC Bus ducts will depend upon the actual layout of transformers and AC distribution boards. AC bus ducts of high electrolytic copper conductor of suitable cross section connecting these station service transformers and AC distribution board shall also be the part of this bid.

Proper coordination and interfacing of sandwich bus duct with SSTs, SSBs. UATs and UABs shall be ensured for smooth integration at respective terminal points.

LT power cables shall be taken out either from bottom or top of the distribution panels in case of double front distribution boards or either from bottom, rear or top of the distribution panels in case of single front distribution boards. Decision to this effect shall be taken at the final engineering of the drawings. Purchaser reserve the right to alter the cable entries, if required during detail engineering, without any additional commercial implication. End terminations between transformers & boards shall be done with flexible braided Cu.

Cables termination compartment and arrangement for power cables shall be suitable for stranded aluminum conductor, armoured PVC insulated and sheathed, single core/three and half core, 1100V grade power cables.

All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. for cables shall be provided by the tenderer, to suit the final cable sizes which would be advised later.

The gland plate shall be of removable type and shall cover the entire cable alley. Tenderer shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory drilled according to the cable gland sizes and number which shall be informed to the tenderer later. For all single core cables, gland plates shall be of non magnetic material.

Heat shrinkable sleeve on horizontal bus bars shall be provided but not in vertical bus bars. Necessary supporting structure for Busduct shall be provided by the bidder.

20.5.3 **Control Voltage**

The control voltage of 220 Volts DC supply between the ranges of 80% to 110% of the rated voltage shall be made available at Power House, PPV

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

House and Dam site only. For other sites i.e. Surge Shaft Area, and Tail Race Outfall area, individual power pack units of sufficient capacity with backup time of 30 mins shall have to be provided by the contractor for control and protection of LT boards/DG AMF panel and is to be included in its bid.

20.5.4 Interlocks

Interlocking scheme shall be as per Drg. no. SJVN/ED/Arun-III/EM-2015-03 for tendering purpose which shall be reviewed and finalized during detailed engineering

20.5.5 Automation of LT Switchgear

Necessary contacts / ports of LT Switchgear (e.g. CB on / off / trip, Voltage supervisions etc.) at all locations shall be envisaged for remote interfacing with the plant SCADA. Logic / program for automation of LT Switchgear shall be built in SACDA.

20.5.6 Protection of 415 Switchgear

The minimum protection for the 415 V system shall be as s per Single Line Diagram SJVN/ARUN III/EM-2017-03 and shall be finalized during detail engineering stage . The relays will be installed on 415V switchgear. All the relays shall be of reputed make with proven performance. In accordance of above, the type of protection shall have to be got approved from the Employer before supply / despatch.

The Contractor has to revise/upgrade the system during detailed engineering if the offered system does not meet the entire requirement. The system should be state of art/latest model available at the time of supply. If the protection system mentioned in the awarded contract become obsolete at the time of supply, the Contractor shall offer a latest model without any extra cost to employer.

The relay used in protection system shall be of the numerical, and plug in type arranged in protection cubicles. All relays including all related devices, such as interposing transformers, tripping matrix and relays, test facilities, power supply units, etc. with all circuits shall comply with relevant IEC Recommendation.

20.6 DRAWING , DOCUMENTS & DESIGN CALCULATIONS

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

After award of contract, the contractor shall furnish all drawings, documents, design calculations, data, manuals & other necessary literature, pertaining to equipment offered by them & so specified under various clauses, in accordance with requirements stipulated in "clause 1.19 of Section – 1 i.e. General Technical Specification (GTS)". A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand for approval of the purchaser as already explained in clause no. 1.19.6 of Section – 1 (GTS). The list of drawings & documents to be furnished for approval / reference shall not be limited to the following:-

i) Drawings, documents, design calculations literatures, manuals etc. as per clause no. 1.19 of Section-1 (GTS)

ii) Drawings, documents, design calculations, literatures, manuals as listed in Annexure – D of Section -1 (GTS) referred under clause no. 1.19.6

iii) Detailed quality assurance plan, giving complete specifications of the materials and specifications relating to inspection and testing of materials and finished components.

iv) All drawings having bearing on civil foundations, equipments foundation details and loads

v) Arrangement, installation, foundation, plan, section, detailing of main equipment and sub-assemblies including control & instrumentation system.

vi) All Electrical, Hydraulic & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of this section.

vii) All manufacturing drawings not specifically covered under approval/reference category shall be submitted for record and facilitate inspection of the component in the shop and assembly at site.

viii) Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work.

20.7 SHOP ASSEMBLY, INSPECTION & TESTS

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

20.7.1 Routine tests

Routine tests shall be carried out on all distribution boards and associated equipments; as per relevant standards.

Each switchboard shall be assembled at the manufacturer's works with all apparatus instruments & meters connected up and the various components shall be tested in accordance with the requirements of the relevant Indian Standard.. The following routine tests shall be performed on all the distribution boards, as per the relevant standards, not limited to :

a) For switchgear assembly **as IEC 60439-1**
   i) Inspection of the assembly including inspection of wiring and if necessary electrical operation test.
   ii) Dielectric test.
   iii) Checking of protective measures and of the electrical continuity of the protective circuit.

b) For air circuit breakers and MCCB's **as per IS 13947**
   i) Mechanical operation test.
   ii) Test for verification of calibration of release.
   iii) Dielectric withstand test

c) For TPN non segregated sandwich type LT Bus-duct:
   i) Verification of dimension & cross-section area.
   ii) One minute high potential power frequency voltage without test.

d) PTs **as per IEC 60044**

   i. Verification of terminal markings
   ii. Power frequency withstand test on secondary winding
   iii. Power frequency withstand test between sections
   iv. Power frequency withstand test on primary windings
   v. Partial discharge measurement
   vi. Determination of errors

e) CTs **as per IEC 60044**

   i. Verification of terminal markings
   ii. Power frequency withstand test on secondary winding

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

iii. Power frequency withstand test between sections
iv. Interturn overvoltage test
v. Power frequency withstand test on primary windings
vi. Partial discharge measurement
vii. Determination of errors

f) Relays, MCBs, switches as per relevant standard.

20.7.2 Type test

Type test of 415 V LT system shall fall under the CAT-II (refer clause no 1.16 of GTS). The type test report of following equipments to be submitted by bidder:

a) Distribution boards- Total assemblies as IEC 60439-1:

i. Temperature rise
ii. Dielectric properties
iii. Short circuit withstand test
iv. Effectiveness of protective circuit
v. Clearance & creepage distance
vi. Mechanical operation
vii. Degree of protection

b) Air circuit breakers/ MCCBs as per IS 13947

i. Temperature rise
ii. Tripping limits and characteristics
iii. Dielectric properties
iv. Operational performance capability
v. Overload performance (where applicable)
vi. Short-circuit breaking capacities
vii. Short-time withstand current

c) For TPN sandwich type LT Bus-duct:

i. High voltage test.
ii. Insulation resistance test.
iii. Short circuit test for a duration and current as specified in the specification.

d) Potential transformers as per IEC 60044

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

i. Temperature-rise tests
ii. Lightning impulse test
iii. Switching impulse test
iv. Determination of error
v. Short circuit withstand capability test
vi. radio interference voltage measurement (RIV)

e) **Current transformer as per IEC 60044**

i. Temperature-rise tests
ii. Lightning impulse test
iii. Switching impulse test
iv. Determination of error
v. Short circuit withstand capability test
vi. radio interference voltage measurement (RIV)

F) Relays, MCBs, switches as per relevant standard.

20.7.3 **Field Tests**

All field tests including tests during installation, pre-commissioning, commissioning, performance and field acceptance tests shall be conducted by the Contractor, in the presence of representative of the Employer.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance tests shall be submitted well in advance, at least four (4) months before start of relevant testing, for approval of the Employer.

20.7.3.1 Tests during installation and pre commissioning

At least following inspections/ tests shall be performed during installation and pre commissioning:

- Functional and operational tests,
- Measurement of the insulating resistance of the different power and control circuits, including cables, instruments and apparatus, against earth,
- Adjustment of the protection equipment,

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

- Calibration of releases,
- Contact resistance measurement of circuit breaker,

- Verification of interlocks: ensure that interlocks are correctly installed and that access is prevented to live portions of the system when interlocks are in place and that access is permitted when interlocks are removed,

20.7.3.2 Commissioning tests

At least following verifications shall be performed before and during energization:

- Insulation resistance measurement of each phase,

- Verification of component temperatures,

- Final adjustment of the protection equipment.

20.7.4 Performance Testing

a) After completion of commissioning tests and commissioning of complete system, If nothing unusual has been observed in load run and load rejection tests, the test service period of 72 hours shall follow. During this test service period, the unit must operate continuously at rated condition without any interruption except of those beyond the control of the Contractor. However, such interrupted period shall not be counted for in the test service period. There should be one month reliability run of the complete unit reckoned from the date of taking over by employer.

b) Remaining Distribution board at all locations shall be kept under charged condition for 72 hrs before taking over. During this test service period, the system / installations must perform satisfactorily & if any defects are observed, same shall be rectified by contractor without any financial implication to employer.

20.8 PACKAGING, HANDLING & SITE STORAGE

The contractor shall be liable for all packing, handling and site storage of all the equipment till the installation is handed over to the Engineer in charge.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

20.9 SITE INSTALLATION AND COMMISSIONING

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

The Contractor shall submit the necessary data/information, layout and foundation/support drawings well in advance.

The Contractor shall provide and install the concrete inserts/embedment,support steels and/or components for foundation/supports purpose as per approved erection drawings and coordinate the activities with civil contractors to keep his activities in synchronism with civil work. All installation for foundation shall be verified and accepted by the Engineer.

The Contractor shall use anchor fasteners for installation of fixtures, mountings, conduits, cabling, panels etc. Chipping of concrete and/or taking support from reinforcement bars shall not be allowed.

20.10 TOOLS AND INSTRUMENTS

20.10.1 Tools for erection and Installation.

The Contractor shall bring his own tools, devices, testing instruments / equipments to site in order to erect and install the complete equipment delivered under this section. These shall remain the property of the Contractor unless otherwise agreed to take over any / all of these at mutually agreed conditions.

20.11 SPARE PARTS

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

STANDARD MANUFACTURING QUALITY PLAN FOR MOTORS (50 KW AND ABOVE RATING)

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	QUALITY PLAN		**CUSTOMER : SAPDC**			**PROJECT** TITLE	**4X225 MW ARUN III HEP**		**SPECIFICATION** NUMBER :	**PE-TS-437-501-A003**		
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE	**100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**		
	SHEET 1 OF 9		SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER HOUSE DOUBLE GIRDER CRANE			SECTION			
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 : SAPDC**			**PROJECT** TITLE **4X225 MW ARUN III HEP**			**SPECIFICATION** NUMBER : **PE-TS-437-501-A003**			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE			**100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**
	SHEET 2 OF 9		SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER			SECTION			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	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./ APPROVED DOC	-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 (As applicable)	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 : SAPDC	PROJECT TITLE 4X225 MW ARUN III HEP	SPECIFICATION NUMBER : PE-TS-437-501-A003
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION TITLE 100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE
	SHEET 3 OF 9	SYSTEM	ITEM: MOTOR (50 KW & ABOVE) FOR POWER	SECTION

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

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

	QUALITY PLAN		**CUSTOMER : SAPDC**			**PROJECT** TITLE	**4X225 MW ARUN III HEP**		**SPECIFICATION PE-TS-437-501-A003** NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE			**100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**
	SHEET 4 OF 9		SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER			SECTION			
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	APPROVED DOCUMENT/ SHEET BEARING MANUF'S CATALOGUES	APPROVED DOCUMENT/ 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./ APP. DOC.	MANUF'S SPEC./ APP. DOC.	-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 : SAPDC	PROJECT TITLE 4X225 MW ARUN III HEP	SPECIFICATION NUMBER : PE-TS-437-501-A003
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION TITLE 100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE
	SHEET 5 OF 9	SYSTEM	ITEM: MOTOR (50 KW & ABOVE) FOR POWER	SECTION

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
2.0	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./ APPROVED DOC	-DO-	-	2	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	APPROVED DOCUMENTS	APPROVED DOCUMENTS	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 : SAPDC**			**PROJECT** TITLE	**4X225 MW ARUN III HEP**		**SPECIFICATION** NUMBER :	**PE-TS-437-501-A003**		
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE	**100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**		
	SHEET 6 OF 9	SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER			SECTION			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./APPROVED DOC	MANUFR'S SPEC./APPROVED DOC	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	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1,4	
		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	-	1,4	THREE DIPS TO BE GIVEN

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

	QUALITY PLAN		**CUSTOMER : SAPDC**			**PROJECT** TITLE **4X225 MW ARUN III HEP**			**SPECIFICATION** NUMBER : **PE-TS-437-501-A003**			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE **100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**			
	SHEET 7 OF 9		SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER			SECTION			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1,4	
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	-	1,4	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1,4	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1,4	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1,4	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1,4	
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	
		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		1,4	

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

	QUALITY PLAN		**CUSTOMER : SAPDC**			**PROJECT** TITLE **4X225 MW ARUN III HEP**			**SPECIFICATION** NUMBER : **PE-TS-437-501-A003**			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE			**100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**
	SHEET 8 OF 9		SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER			SECTION			
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-12615/ APPROVED DOC/ DATA SHEET	IS-12615/ APPROVED DOC/ DATA SHEET	TEST REPORT	2	1*	1,4	
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1,4	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1,4	$ 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	APPROVED DOCUMENT	TC	2	-	1,4	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1,4	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1,4	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & APPROVED DOCUMENTS	IS-325 & APPROVED DOCUMENTS	INSPC. REPORT	2	1$	1,4	$ NOTE - 2
		9. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	APPROVED DOCUMENTS	APPROVED DOCUMENTS	TC	2	1$	1,4	

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

	QUALITY PLAN		**CUSTOMER : SAPDC**			**PROJECT** TITLE **4X225 MW ARUN III HEP**			**SPECIFICATION** NUMBER : **PE-TS-437-501-A003**		
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION TITLE **100/20T TRANSFORMER CAVERN AREA D/G EOT CRANE**		
	SHEET 9 OF 9		SYSTEM			ITEM: MOTOR (50 KW & ABOVE) FOR POWER			SECTION		
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

NOTES:

1 IN CASE TEST CERTIFICATES ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR WITNESSED BY LAB / CLIENT DURING LAST FIVE YEARS FROM BID OPENING DATE I.E. 09.02.2018, THEN TYPE TEST IS NOT REQUIRED & REPORT SHALL BE SUBMITTED FOR REIVEW.

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

Legends for Inspection agency

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

P. PERFORM
W. WITNESS
V. VERIFY

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

SUB-SECTION IC

DATASHEET - A

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

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 Transformer cavern 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**	One number
1.5..0	**Crane classification**	M5 (Mechanical, Electrical & structural) as per IS: 3177, IS: 807-2006 and 13834 (part-5)-1993
1.6.0	**Suitable for outdoor or indoor duty**	Indoor
1.7.0	**Capacity (T)**	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

1.7.1	**Main hoist**		
	Rated SWL – tones	100T	
	Test load SWL – tones	Rated SWC and over load test : 125% of SWC	
1.7.2	**Aux. Hoists**		
	Rated SWL – tones	20	
	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	**Operation from**	pendant push button+ Radio Remote Control	
2.0.0	**CRANE PERFORMANCE**		
2.1.0	Crane speed with full load (mtrs/min.)		
	Main Hoist	Refer Clause no. **23.3.2** of chapter 23- EOT cranes, Section IA-Customer specification	
	Aux. Hoist		
	Crab travelling speed (CT motion)		
	Crane travelling speed (LT motion)		
	Creep speed M/Min	@ 5 % 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 1000 mm and 500 mm and vertical post spacing not exceeding 1100 mm as far as possible but can be adjusted to suit the length of railing with provision of kick plate (100 mm high and 6mm thick)	
3.0.0	**COMPONENT DETAILS**		

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

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	
f	Other requirements	Refer Clause no. 23.4.8.1.D of chapter 23- EOT cranes, Section IA-Customer specification	
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	*	*
	Other requirements	Refer Clause no. 23.4.9.3.4 of chapter 23- EOT cranes, Section IA-Customer specification	
3.3.0	**Rope details**		
a.	Standard	IS:2266	
b.	Construction	Extra flexible plough steel / 6x36 construction or equivalent	
c.	Grade	1770/ 1960	
d.	Diameter in mm	*	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

e.	Breaking strength	*			
f.	Factor of safety	6			
g.	Type of core	Steel			
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			
e.	Other requirements	Refer Clause no. 23.4.9.3.5.b of chapter 23- EOT cranes, Section IA- Customer specification			
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			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

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 M5 duty			
c.	Total no. of reductions	*			
d.	Type of gears	Helical / Spur	NA (Through VVVF drive)	Helical / Spur	NA (Through VVVF drive)

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

e.	Reduction Ratio	*			
f.	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication			
g	Difference in Gear and pinion hardness	Min 20 BHN			
h.	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 OR Hardened and ground gears & pinions. Material (gear/pinions) -815M17 / En353. The hardness of gears & pinions shall be in the range of 560 - 580BHN.			
i.	Casings	Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved			
j.	Noise Level	85db			
k.	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 M5 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.	Difference in Gear and pinion hardness	Min 20 BHN			
h.	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 OR Hardened and ground gears & pinions. Material (gear/pinions) - 815M17 / En353. The hardness of gears & pinions shall be in the range of			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

		560 - 580BHN.	
i.	Casings	Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved	
j.	Noise Level	85db	
k.	Standard conforming to	IS 4460 / AGMA	
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	8
j.	Specification conforming to	IS: 3177 (latest edition)	
k	Arrangement of lubrication	Grease	
l	Other requirements	Refer Clause no. 23.4.8.1.C of chapter 23- EOT cranes, Section IA- Customer specification	
3.8.0	**Lifting hooks**		
		MH	**AH**
a.	Type	Ram shorn, shank with safety latch swiveling type as per latest edition of IS: 5749	Shank type with safety latch swivelling type as per latest edition of IS 15560 and TS
b.	Safe lifting capacity	100T	20T
c.	Material	➢ Class 2 as per IS 1875:1992 (re affirmed 2004) for hooks conforming to IS : 5749	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

		➢ 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 swiveling hook required or not	Provided	
h	Other requirements	Refer Clause no. 23.4.9.3.5.c & d of chapter 23- EOT cranes, Section IA- Customer specification	
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**		
3.10.0.1	**Hoist Motions**	Main Hoist	Aux. Hoist
a.	Type of brake	Regenerative braking + Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro magnetic (double brake disc type)	Regenerative braking + Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro magnetic (double brake disc type)
b.	Diameter of brake	*	*
c.	Torque rating	*	*
d.	Number provided per motor	1+1	1+1
e.	Braking capacity(% of torque transmitted to the brake drum with full load.)	150% of full load torque of motors	150% of full load torque of motors
f.	Braking torque actually required	*	*
g.	Material		
i.	Brake Liner	Ferrodo liners	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

ii.	Drum	CS IS : 1030 / CL 4 IS : 1875	
iii.	Springs	As per manufacturers standard	
h.	Braking Distance in mm	*	
i	Other requirements	The brakes system shall have the following provisions:- a) Locking device in the brake lever. b) Means for adjustment to compensate for wear of the shoes. c) Emergency stop push buttons. Further refer Clause no. 23.4.9..4 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements	
3.10.0.2	**Travel Motions**	CT	LT
a.	Type of brake	Regenerative braking + Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro magnetic (double brake disc type)	Regenerative braking + Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro magnetic (double brake disc type)
b.	Diameter of brake	*	*
c.	Torque rating	*	*
d.	Number provided per motor	1+1	1+1
e.	Braking capacity(% of torque transmitted to the brake drum with full load.)	150% of full load torque of motors	150% of full load torque of motors
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	*	
i	Other requirements	The brakes system shall have the following provisions:- a) Locking device in the brake lever. b) Means for adjustment to compensate for wear of the shoes. c) Emergency stop push buttons. Further refer Clause no. 23.4.9..4 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements	
3.10.0.3	**Holding Clamps Against Earthquake (for CT and LT both)**	To be provided for crane to withstand the seismic events and earthquake. Refer Clause no. 23.4.9.11 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV.0

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	Grease lubrication
d.	Bearing life	10,000 working hours.
e.	Other requirements	Refer Clause no. 23.4.9.7, 23.4.9.8 and 23.4.9.9 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements
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. 23.4.8.1. A of chapter 23- EOT cranes, Section IA-Customer specification for other requirements
b.	Size	*
c.	Maximum Vertical Deflection	The total maximum vertical deflections for the girder for the safe weight of working load plus the weight of crab in central position (Without taking in to consideration the impact factor) will not exceed limit of span/750 for crane (if span of the crane is more than 12m), and span/600 for crane (if span of the crane is less than 12m) as per IS 807.
d.	Type of connection to end carriage	By fitted bolts
e.	Length	*
f.	Width	*
3.14.0	**Rails (CT & LT) along with sole plates, anchor bolts & accessories**	
a.	Type / section	Rails sections as per IS: 3443.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

b.	Standard conforming to	IS: 3443			
c.	Weight per meter	*			
d.	Material	50C12 or 55C11			
e.	Rail	CR-100			
f.	Top width in mm	*			
g	Height in mm	*			
h	Other requirements	Refer Clause no. 23.5.3.1 of chapter 23- EOT cranes, Section IA- Customer specification for other requirements			
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. 23.4.8.1 E 2 of chapter 23- EOT cranes, Section IA- Customer specification for other requirements			
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.	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	SC, suitable for Inverter duty	NA	SC, suitable for Inverter duty	NA
b.	Enclosure	TEFC	NA	TEFC	NA
c.	Numbers furnished	1	NA	1	NA
d.	Voltage, phase and frequency	3 Ph., 4 wire, 415V + 10%, 50 Hz + 3% Any Combined voltage & frequency variation upto above limits.			
e.	Class of protection	IP-54			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

f.	Rated capacity (KW)	The motor shall be suitable for 300 starts / hr and 40% CDF. Motor nameplate rating at 40^{0}C shall have Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement in the duty condition specified.			
g.	Rating	S4, 40 % CDF			
h.	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B. Max. Temperatures rise at full load measured by resistance method shall not exceed 60° C over the average ambient temp of 40° C .			
i.	Number of starts/ hour	300 starts / hr			
j.	Pull out torque	The pull out torque of the motor will not be less than 225 % of the full load torque at rated voltage and frequency			
k.	Space heater requirement	To be provided in case motor capacity is 20 kW (To suit 240 V AC Supply).			
l.	Speed	*			
m.	Contactors for motors	*			
n.	Other requirements	The motor speed not to exceed 105 % of the synchronous speed while lowering the rated load. Further refer Clause no. 23.4.10.2 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements.			
10.2	**Travel Motions**	**CT**	**CT micro**	**LT**	**LT micro**
a.	Type	SC, suitable for Inverter duty	NA	SC, suitable for Inverter duty	NA
b.	Enclosure	TEFC	NA	TEFC	NA
c.	Numbers furnished	2	NA	4	NA
d.	Voltage, phase and frequency	3 Ph., 4 wire, 415V + 10%, 50 Hz + 3% Any Combined voltage & frequency variation upto above limits.			
e.	Class of protection	IP-54			
f.	Rated capacity (KW)	The motor shall be suitable for 300 starts / hr and 40% CDF. Motor nameplate rating at 40^{0}C shall have Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement in the duty condition specified.			
g.	Rating	S4, 40 % CDF			
h.	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B. Max. Temperatures rise at full load measured by resistance method shall not exceed 60° C over the average ambient temp of 40° C .			
i.	Number of starts/ hour	300 starts / hr			
j.	Space heater requirement	To be provided in case motor capacity is 20 kW (To suit 240 V AC Supply)			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

k.	Pull out torque	The pull out torque of the motor will not be less than 225 % of the full load torque at rated voltage and frequency			
l.	Speed	*			
m.	Contactors for motors	*			
n.	Other requirements	Refer Clause no. 23.4.10.2 of chapter 23- EOT cranes, Section IA- Customer specification for other requirements			
3.17.0	**Limit switches**	**Main hoist**	**Aux. Hoist**	**Cross Travel**	**Long Travel**
a.	Type	Rotary gear (screw type 2 nos.) + Gravity limit switch (manual reset in case of over travel)	Rotary gear (screw type 2 nos.) + Gravity limit switch (manual reset in case of over travel)	Lever type (one way/ two way)	Lever type (one way/ two way)
b.	Number provided per crane	2 + 1	2 + 1	2/1	2/1
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)**				
a.	Type	LT: PVC shrouded Copper conductor bus bar CT : Flexible trailing cable mounting on retracting support (Festoon type) EPR insulated and CSP Sheathed type			
b.	Size	Shall be sized with a margin of 20% over load requirement. Voltage drop at motor terminal shall be limited to 2% 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			
g.	Other requirements	Refer Clause no. 23.4.10.11 of chapter 23- EOT cranes, Section IA- Customer specification for other requirements			
3.19.0	**Protective & Control panel**				
	Make	OEM			

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

	Size	*	
	Material	Rolled sheet steel 2mm size, fabricated from 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	
3.21.0	**Cable**	**Power**	**Control**
	Material	Copper	Copper
	Size	Suitable size as per current rating	Suitable size as per current rating
	Type	FRLS insulated, multi strand Copper PVC sheathed armoured cable conforming to IS: 1554 (part-I) (for fixed cables) and PVC/ TRS/ EPR insulated CSP sheathed cable (for flexible cable)	
	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:-	Permanent Cable from 1 feeder from feeder board (located at operating floor of transformer cavern area) to Changeover cum Isolator switch shall be in Bidder's scope. Approximate length of cable required shall be 80 m. This is in addition to the cables required from isolating switch to DSL and other cables required for operation of crane.	
3.22.0	**Earthing**		
a.	Material of earthing	GI / Copper	
b.	Earthing as per specification	Yes, Refer Clause no. 23.4.10.5 and 23.5.2 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements	
3.23.0	**Contactors**	AC 4 duty for reversing application. AC 3 duty for non-reversing application. For other details, refer Clause no. 23.4.10.9.3 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements	
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**		
a.	Type and size	4.5 kg , CO_2 type	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

b.	Numbers & Location	Two number on bridge
3.25.0	**Power Supply**	Power supply feeder (1no.) shall be available at operating floor of Transformer cavern area
3.26.0	**Transformer**	
a.	Quantity	2 X 100 % - 415/110V (for control), 2 X 100 % - 415/240V (for lighting)
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**	
a.	Over Bridge	4 nos 40 W fluorescent with incandescent lamps/ Equivalent luminosity of LED lamps and 4nos. 240V – 5A – 3 pin industrial socket
b.	Under bridge.	2 nos.1000 W HPSV lamps/ Equivalent luminosity of LED flash lamps
c.	For inspection of crane components	One (1) portable 40W hand lamp with 25m length flexible cable for inspection of crane components
d.	Hand lamp socket and hand tool sockets	Hand lamp socket outlets (2 pin, 10A, 24V) and power socket outlets (3 pin, 20A, 240V) shall be provided for use of hand tools along with switches.
e.	Other requirements	Refer Clause no. 23.5.1 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements
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
e.	Other requirements	Refer Clause no. 23.4.10.4 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements.
28.0	**Sweep**	Sweep shall be attached to the end carriages and to the trolley to remove foreign materials from the rails.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

29.0	**Painting & Color Coding**	As per Annexure IV: PAINTING SPECIFICATION
30.0	**Main Isolating switch**	At center of bay length(to be decided during detail engineering)
32.0	**Additional features on pendant push button**	-Emergency Push Button (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 along with display**	To be provided in accordance with the Clause 15.12 of IS 3177. Further Digital display monitoring device on front side of EOT crane to be provided.
36.0	**Slings**	
36.1	**Quantity and capacity**	6 pair of Slings (consists of 100T, 60T, 40T, 20T, 10T, 5T slings)
36.2	**Storage rack for the sling**	To be provided
36.3	**Other requirements**	The slings shall be suitable to use with hoist. 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. For other details refer Clause no. 23.4.9.3.6 of chapter 23- EOT cranes, Section IA-Customer specification for other requirements.
36.4	Length of slings	8 m for 60T, 40T, 20T, 10T, 5T slings and 12 m for 100T slings. For overload test of crane, cradle & sling already supplied for higher capacity crane by BHEL, shall be used.

Note: Other requirements for the system.

- Please refer chapter 23- EOT cranes, Section IA-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.
- Temporary cables shall not be used as Permanent cables.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

SECTION – II
STANDARD TECHNICAL SPECIFICATION

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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..

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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^{o}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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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 $\pm$ 20 deg. C and at no time during the soaking cycle the temperature shall fall below 590 deg. C or exceed 680 deg. C. Soaking shall be done for a period proportionate to 1 (one) hour/ 2.5 cm. of wall thickness**.**

3.3.10 **Bearing**

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

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

3.3.11. **Shafts, Couplings and axles**

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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,

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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**

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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:

s per attached sub vendor list

SECTION III

1. DOCUMENTS TO BE SUBMITTED ALONG WITH BID
2. PRE-BID CLARIFICATION SCHEDULE
3. COMPLIANCE CUM CONFIRMATION CERTIFICATE
4. ELECTRICAL LOAD LIST

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

DRAWINGS / DOCUMENTS TO BE SUBMITTED WITH THE BID

Bidder shall submit the following drawings / documents along with their bid:

a) Deviation schedule with reference to specific clauses of the specification along with reason for such deviation in the 'Deviation Schedule' (Cost of withdrawal) format as attached in GCC.

b) Un-priced copy of price format indicating quoted/ not quoted against each row/column

c) Copy of pre-bid clarifications/ amendment/ corrigendum issued by BHEL, if any, duly signed & stamped

d) Signed/ Stamped copy of Compliance cum Confirmation Certificate

e) Signed & stamped copy of filled up electrical load list

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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.

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0

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 100/20T for Transformer cavern Area		46 KW	S	1	0	D	S	N	I		In Transformer caver area							

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.	437	ORIGINATING AGENCY		PEM (ELECTRICAL)	
		PROJECT TITLE	4x225 MW ARUN-3 HEP NEPAL	NAME		DATA FILLED UP ON	
		SYSTEM / S	DG EOT CRANE (100T Capacity)	SIGN.		DATA ENTERED ON	
		DEPTT. / SECTION	MAX/MATERIAL HANDLING	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

TECHNICAL SPECIFICATION NO. PE-TS-437-501-A003, REV 0