

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

PROJECT: 1X660 MW PANKI EXTN

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

SPECIFICATION NO.: PE-TS-426-501-A101



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



TECHNICAL SPECIFICATION FOR
D/G EOT CRANE UPTO 100T
1X660 MW UPRVUNL PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-501-A101

REV 00

DATE MAY 2019

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SPECIFIC TECHNICAL REQUIREMENT (MECHANICAL)

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SCOPE OF ENQUIRY/INTENT OF SPECIFICATION

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

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purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

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

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CHAPTER 2 : GENERAL PROJECT INFORMATION

1.0 PROJECT INFORMATION

1.1	Owner	:	UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED, LUCKNOW	
1.2	Project Title	:	Panki Thermal Power Station (1x660MW)	
1.3	Owner's Engineer	:	DEVELOPMENT CONSULTANTS PVT. LTD	
1.4	Project Site Location	:	Place	Panki
		:	District	Kanpur
		:	State	Uttar Pradesh
		:	Country	India
1.5	Latitude & Longitude of project site	:	North	N26 ⁰ 28'20"
		:	East	E 80 ⁰ 14'32"
1.6	Nearest Railway Station	:	Panki	5 km
1.7	Nearest Town	:	Kanpur	16km
1.8	Nearest Highway	:	National Highway - 25	
1.9	Nearest Airport	:	Kanpur	25 km
		:	Lucknow	80 Km
1.10	Nearest Commercial Airport	:	Delhi	140 km
1.11	Nearest Water Body	:	Lower Ganga Canal, adjacent to site	
1.12	Land	:	Land is in possession of UPRVUNL.	
1.13	Station Graded Level Elevation from Mean sea level (MSL)	:	Plant FGL → RL(+) 126.0M → El(-) 0.500M Plant FFL → RL(+) 126.5M → El(+/-) 0.000M	
1.14	Water	:		
1.14.1	Nearest Water Source	:	Lower Ganga Canal system running adjacent for project site	
1.14.2	Water Requirement for station	:	~ 1927 m ³ /hr considering closed cooling cycle with NDCT. Additional 700m ³ /hr for ash slurry preparation during emergency ash disposal to ash dyke.	
1.14.3	Raw Water Analysis from Upper Ganga Canal	:	Refer Appendix - I	
1.15	Site Ambient Condition	:		
1.15.1	Monthly mean (DBT)	:	Maximum	44.4 °C
		:	Minimum	3.8 °C
1.15.2	Extreme Recorded (DBT)	:	Maximum	47.3 °C
		:	Minimum	-0.9 °C
1.15.3	Monthly mean (WBT)	:	Maximum	27.3 °C
		:	Minimum	9.2 °C
1.15.4	Relative Humidity	:	Maximum	84 %
		:	Minimum	28 %
1.15.5	Average relative humidity	:	Annual Average	65 %
1.15.6	Rainfall	:	Annual average	832.6 mm



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			Heaviest fall recorded in 24 hrs	247.4 mm
1.15.7	Basic Wind Speed	:	47.00 m/s	As per IS: 875 part – III
			For wind resistance design of structure & equipment refer relevant civil section	
1.15.8	Climatic condition	:	For detailed information refer attached Climatological data as published by IMD for Kanpur station.	
1.16	Seismic data	:	Zone – III	As per IS: 1893
			For earthquake resistance design of structure & equipment refer relevant civil section	
1.17	Fuel Data			
1.17.1	Coal Source	:	Coal requirement for this stage of the project is estimated as 2.99 million tones/annum considering 660 MW capacity, GCV of blended coal 4030 kcal/kg, Heat Rate as 2317 kcal/kwh and 90% PLF as per CERC operative norms effective from 1/4/2009.	
1.17.2	Coal Transportation	:	Thru BOXN wagons of Indian Railways System	
1.17.3	Coal Analysis	:	Refer Appendix – II	
1.17.4	Support Fuel (HFO / LDO) transportation	:	Support fuel will be transported by road tankers or by Railway system. Start-up / support fuel for the proposed project will be LDO/HFO.	
1.17.5	Support Fuel (HFO / LDO) analysis	:	Refer Appendix - II	

Appendix – I: Raw Water Analysis (Source - Lower Ganga Canal)

S. No.	Description	Unit	Parameter
1	Physical characteristics		
	pH at 25°C	-	8.00
	Turbidity	Silica Scale	500
	Total Suspended solids	ppm	250
	Total Dissolved solids	ppm	241
	Colour	Hazen	< 5
2	Cations		
	Calcium Hardness	ppm as CaCO ₃	80
	Magnesium Hardness	ppm as CaCO ₃	40
	Sodium + Potassium	ppm as CaCO ₃	36
	Iron	ppm as CaCO ₃	1.5
	Total Cations	ppm as CaCO ₃	157.5
3	Anions		
	Bicarbonate	ppm as CaCO ₃	100
	Carbonate	ppm as CaCO ₃	0.95



S. No.	Description	Unit	Parameter
	Hydroxyl	ppm as CaCO ₃	0.05
	Chlorides	ppm as CaCO ₃	20
	Sulphate	ppm as CaCO ₃	36
	Nitrate	ppm as CaCO ₃	0.5
	Total Anions	ppm as CaCO ₃	157.5
4	Carbon Di-oxide as CO ₂	ppm	1.97
5	Dissolved Silica	ppm as SiO ₂	10.0
6	Colloidal Silica	ppm as SiO ₂	0.5
7	Organic Matter	ppm as O ₂	4.0

Appendix – II : Coal Quality Parameter

Sl. No.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
1.0.	Proximate Analysis (As Received Basis)	By Weight			
1.1.	Moisture	%	10.5	12	12
1.2.	Ash	%	35	43	32
1.3.	Volatile Matter	%	26	19	27
1.4.	Fixed Carbon	%	28.5	26	29
1.5.	Total	%	100	100	100
1.6.	Gross Calorific Value	kcal / kg	3700	3200	4200
2.0.	Ultimate Analysis (As Received Basis)				
2.1.	Moisture	%	10.5	12	12
2.2.	Ash	%	35	43	32
2.3.	Carbon	%	42	33.5	44
2.4.	Hydrogen	%	2.0	2.4	2.77
2.5.	Nitrogen	%	1.6	1.3	1.5
2.6.	Sulfur	%	0.46	0.45	0.5
2.7.	Oxygen	%	8.44	7.35	7.23
2.8.	Total	%	100	100	100
3.0.	Hard Groove Index		53	50	55
4.0.	Ash Fusion Range				
a)	Initial Deformation Temperature	⁰ C	1200	1154	1165
b)	Hemispherical Temperature	⁰ C	1350	1300	>1350

Sl.No.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
c)	Fusion Temperature	°C	>1400	>1400	>1400

Source: Saharpur Jamarpani Coal Mine, Jharkhand
Imported Coal

Sl. No.	Item	Unit	Design Coal
1.	Gross heating Value	Kcal/kg	5500

Source: Indonesia / South African coal

Appendix – III : Light Diesel Oil (LDO)
As per IS: 1460-2000

S.No.	Property	Unit	Value
1.0	Ash content (max)	% by mass	0.02
2.0	Carbon residue (Rams Bottom) max	% by mass	0.2
3.0	Cetane number (Min)	-	-
4.0	Pour Point (max)		
	a) Winter	°C	12
	b) Summer		21
5.0	Flash Point (min)		
	a) Abel	°C	--
	b) Pensky0Martens		68
6.0	Kinematic Viscosity at 38 deg	Cst	2.5 to 15.7
7.0	Sediments (max)	% by mass	0.1
8.0	Sulphur Content (max)	% by mass	1.8
9.0	Water Content (max)	% by volume	
10.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000
11.0	Density at 15°C	Kg/m ³	850 to 870

Appendix – IV : Heavy Fuel Oil (HFO)
As per IS: 1593-1982

S.No.	Property	Unit	Value
1.0	Viscosity at 50 °C	Cst	370
2.0	Density at 15°C (approx)	Kg/m ³	890 to 950
3.0	Flash Point (min)	°C	66
4.0	Pour Point (max)	°C	20
5.0	Water Content (max)	% by volume	1
6.0	Sediments (max)	% by weight	0.25
7.0	Sulphur Content (max)	% by weight	4.5
8.0	Ash content (max)	% by weight	0.1
9.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000

2.0 Access to Site

The nearest town Kanpur is about 16 km from site. It is easily accessible by Railway/Road.



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Dedicated railway link is available for the transportation of coal and fuel oil for the power plant. No problem is envisaged in accessibility and transportation of heavy equipment to site by road or rail.

3.0 Plant Rating, Capacity, Availability, PLF

Plant continuous rating will be 660 MW at generator terminals based on the following site conditions.

- Ambient air temperature
- Condenser cooling water inlet temperature of 33°C and 10°C temperature rise across the condenser.
- Generator power factor of 0.85 (zero point eight-five).
- Fuel specification as given elsewhere.
- Design temperature for electrical equipment is 50°C.

The VWO capacity of the steam turbine 660 MW will be 105% or 693 MW and the Boiler maximum Continuous Rating (MCR) will be established to match the steam requirement at VWO conditions. The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc.

4.0 Power Evacuation

The power generated from the proposed project will be evacuated over the 400 KV through a 400 KV open switchyard. Further to Switchyard distribution will be by UPTRANSCO. Interconnection of proposed 400 KV Switchyard with existing 220 kV switchyard shall be done as specified elsewhere in specification.



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1.0.0. SCOPE OF WORK

1.1.0. SCOPE OF SUPPLY

1.1.1. Equipment and services to be furnished by the bidder for double girder EOT Cranes upto 100T with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the EOT crane complete for efficient operation shall also be under the bidder's scope of work.

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

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

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

1.1.4 Maintenance Tools and Tackles

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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 its use. The items supplied shall be of the best quality. The minimum 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. The Purchaser shall retain the unutilized commissioning spares. Fill of lubricants; oil etc. till commissioning of the cranes shall also be supplied by the bidder.

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

1.2.0 Services to be provided by the bidder

1.2.1. Packing, forwarding and transportation to site

1.2.2. Development of storage space including ward & watch of the equipment and handling at site.

1.2.3. Unloading, storage and handling at site.

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

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



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1.2.4. Arranging test load at site

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

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

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

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

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

1.3.0 PAINTING & COLOUR SCHEME

As per Annexure IV, section-IA of this specification

2.0.0. Works Excluded

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

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-IA 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 Section III and furnishing full particular of such deviations. Deviations are to be

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furnished with mention to specific clause number (reasons / explanations for such deviations shall be furnished). Notes / comments etc. is not acceptable. If there are no deviations from the tender document, bidder shall mention “**NO DEVIATION**” in cost of withdrawal of deviation format.

5.0.0. Makes of Sub - Vendor items

Makes of bought out items as per Annexure-I, section 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.

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.

7.1.0 Testing at site

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

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



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- vi. Any other test as per IS-3177

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

8.0 Consumables

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

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QUALITY ASSURANCE AND INSPECTION REQUIREMENT

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1.1.0. Inspection and Testing

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

1.1.1. Inspection and testing at Manufacturer's works

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

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

STAGE INSPECTION

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

- i. All test certificates shall be in original and legible. Photocopies certified by Mill/ manufacturer of raw material used, are acceptable.
 - ii. For tensile testing of hooks/ forgings, samples shall be drawn from the full cross section of the shank diameter of hooks/ forgings Samples forged to reduced cross section for testing purposes is not acceptable. **Hooks shall be manufactured from Blooms, billets, rounds by forging with forging ratio of at least 3:1. Hooks manufactured from plates are not acceptable.**
 - iii Radiographs shall be inspected to a sensitivity of 2%.
 - iv Ultrasonic test on forgings and casting of critical components like cross head (hook suspension block), Hooks, Shafts, Axles, Gears, Wheels, Pulleys etc. Ultrasonic test on forgings shall be carried out as per norms given below. UT shall be carried out in Proof machined condition (single diameter/ Flat surface without steps, keyways, teeth cutting or other profile machining which can create difficulty in ultrasonic testing). Components shall be identified with Heat number and serial number by punching). Hardening operation shall be carried out prior to Ultrasonic testing.
- Unacceptable defects in forgings are as given below:
1. Cracks, flakes, seams and laps
 2. Defects giving indication larger than '4 (four) mm diameter equivalent flaw' except for wheels for which Defects giving indication larger than '6 (six) mm diameter equivalent flaw.'

PART OF SPECIFICATION PE-TS-426-501-A101



**TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN**

SPECIFICATION No: PE-TS-426-501-A101

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

SECTION-I

SUB-SECTION-IA

REV. 00

DATE: MAY 2018

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

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

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

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

FINAL INSPECTION- Testing At Works.

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

- a) Deflection test of bridge girder at rated load. Crane shall rest on centerline of LT wheels.
- b) Load test and Overload test (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.

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

Refer Testing requirement as mentioned at ANNEXURE-VII.

PART OF SPECIFICATION PE-TS-426-501-A101

MANUFACTURER'S NAME & ADDRESS				MANUFACTURING QUALITY PLAN (FOR REFERENCE)										PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T)			
एन एल सी एम 				ITEM:		QP NO : PE-V0-426-501-A101		CONTRACT NO :		CONTRACTOR :		VENDOR'S QAP No :		REMARKS			
						REV : 0											
						DATE : MAR 2019											
SL.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	TYPE PF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS		AGENCY		REMARKS					
1	4	3	4	5	6	7	8	9	D**	10	11						
1	Fabricated components																
a	Box Girder, End Carriage, Crab Frame, Rope Drum																
	Material	Chemical & Physical Properties	Major	Corelation	1/Heat/Batch	IS:2062-Gr B	IS:2062-Gr B	Mfr's T.C/	✓	P	V	V					
				with T.C.				Vendor's					Refer note: 1				
				Check test in absence of T.C.				T.C.									
		U.T of plates.		Ultrasonic	100%	ASTM A435	ASTM A435	T.C. / I.R.	✓	P	V	V	U.T. ON ABOVE 25MM THICK PLATE				
b	weld setup	dimensions	Major	Measurement	100%	Components drawings	Components drawings	Vendor's inspection report									
	Seamless pipe for rope drum		major	Co relation with TC, check in	100%	ASTM A106Gr B	ASTM A106Gr B	MTC/Lab TC	✓	P	V	V	Refer note: 1				
		NDT	Major	macro etching & flattening	100%	ASTM A106Gr B	ASTM A106Gr B	MTC/Lab TC	✓	P	V	V					
		NDT	Major	UT	100%	ASTM E-213-2007	notch depth shall not be more than 12.5% of thickness of pipe	IR	✓	P	V	V					
2	Welding WPS (Welding procedure specification) in line with ASME sec. IX (QW - 482) - For Box Girder, End Carriage, Crab Frame, Rope Drum																
a	Check for welding procedure quification, welder's performance	Welding parameters	Major	check & test	100%	ASME Sec-IX	ASME Sec-IX	QW-482,QW-483	✓	P	V	V	CUSTOMER APPROVED WPS AND CUSTOMER QUALIFIED WELDERS ACCEPTABLE.				
								QW-484 ASPER									
								asme Sec-IX									
b	Back chipping	surface defect	Major	DPT	100%	ASME Sec-VIII, Div-I, Appen - 8	ASME Sec-VIII, Div-I, Appen - 8	Vendor insp. Report		P	V	V					
c	Butt Welds	NDT	Critical	Gamma ray	100% in tension	ASME Sec - VIII	ASME Sec-VIII, CL UW51	Vendor insp	✓	P	V	V	Review of inspection report & radiography report and RT films - Refer				
				Radiography	25% in			Repot									

MANUFACTURER'S NAME & ADDRESS				MANUFACTURING QUALITY PLAN (FOR REFERENCE)				PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T) CONTRACT NO : CONTRACTOR : VENDOR'S QAP No : DATE : MAR 2019			
ITEM:				QAP NO : PE-V0-426-501-A101	REV : 0	CONTRACT NO :		CONTRACTOR :			
				DATE : MAR 2019							
SL. NO.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY	REMARKS	
1	4	3	4	5	6	7	8	9	10	11	
					compression						
					100% in rope drum			RT film		note: 2	
			Critical	DPT	100%	IS: 3658	ASME Sec-VII,	Vendor insp	P	V	DP test of filletweld for
							Appen - 8	Report			rope drum to be conducted
											after final machining
											Random witness by
											BHEL
d	fillet welds	Size and surface defects	Major	Visual	100%	Component Drg.	Component	Vendor insp. Report	P	V	
			Major	DPT	10% RANDOM	ASME Sec VIII-Div1-Append 8	ASME Sec VIII-Div1-Append 8	Vendor insp. Report	P	V	
e	final inspection of fabricated components listed in Sr.1 above	Dimensions for Girder, end carriage rope drum etc. Camber, Verticality, bend etc	Major	Dimensional Measurement	100%	Vendor Mfg. Drg.	Vendor Mfg. Drg.	Vendor route card/vendor insp report	P	V	
f	Heat treatment of rope drum	Stress relieving	Major	Review of SR chart	100%	ASME Sec-VIII, Div - I	ASME Sec-VIII, Div - I	SR Chart	P	V	If fabricated from M.S Plate
3	Gear box casing										
a	Material	Surface condition	Major	Visual	100%	Component Drg.	Component Drg.	Vendor insp Report	P	V	Refer note 1
		Chemical & mech	Major	Measurement	100%	Component Drg.	Component Drg.	T.C. & I.R.	P	V	
				Correlation with	100%	IS:2062	IS:2062				
				T.C. Check test in absence of T.C.							
				Correlation							

MANUFACTURER'S NAME & ADDRESS				MANUFACTURING QUALITY PLAN (FOR REFERENCE)										PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T)					
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				TYPE PF		QUANTUM	REFERENCE	ACCEPTANCE	FORMAT OF		AGENCY								
				CHECK	5	6	DOCUMENT	NORMS	RECORDS	M	C	N							
				DATE : MAR 2019				7	8	9	D**	10							
SL. NO.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	5	6	7	8	9	D**	10									
1		3	4														11		
b	welding	Welding & Dimensional conformity	Major	Measurement	100%	Component Drg.	Component Drg.	Vendor insp			P								
c	Heat treatment	stress relieving	Major	Review of SR chart	100%	Component Drg./	Component Drg./	Vendor insp			P	V	V						
						ASME Sec-VIII, Div - I	ASME Sec-VIII, Div - I for procedure.	Report											
4	PLATFORMS	Dimensional conformity	Minor	Measurement	100%	Components Drg.	Components Drg.	Vendor insp			P	V	V	Refer note: 1					
								Report											
5	L.T.FRAMES	Dimensional conformity	Minor	Measurement	100%	Components Drg.	Components Drg.	Vendor insp			P	V	V						
								Report											
6	HAND RAILINGS	Dimensional conformity	Minor	Measurement	100%	Components Drg.	Components Drg.	Vendor insp			P	V	V						
								Report											
7	Current collector arms	Dimensional conformity	Minor	Measurement	100%	Mfr. Catalog	Mfr. Catalog	Vendor insp			P	V	V						
								Report											
8	DSL Guard	Dimensional conformity	Minor	Measurement	100%	Components Drg.	Components Drg.	Vendor insp			P	V	V						
								Report											
9	Rails	Dimensional conformity,	Minor	Measurement	100%	G.A.drg./IS : 3443 Vendor T.C./Appd.Data Sheet	G.A.drg./IS : 3443 Vendor T.C./Appd.Data Sheet	IR			P	V	V						
		Chemical , tensile & hardness	Major	Chemical & hardness	100%	IS-3443	IS:3443	IR			P	V	V						
10	MECHANICAL COMPONENTS																		
A	a) wheels																		

MANUFACTURER'S NAME & ADDRESS				MANUFACTURING QUALITY PLAN (FOR REFERENCE)										PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T)					
				ITEM:				QP NO : PE-V0-426-501-A101 REV : 0 DATE : MAR 2019				CONTRACT NO : CONTRACTOR : VENDOR'S QAP No :				REMARKS			
				TYPE PF CHECK		QUANTUM OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORMS		FORMAT OF RECORDS		AGENCY		AGENCY			
				5		6		7		8		9		M		C			
				5		6		7		8		9		M		C			
1	SL. NO.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	TYPE PF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY	AGENCY	AGENCY	AGENCY	AGENCY	AGENCY	AGENCY	AGENCY		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C	N	M	C	N	M	C		
		4	3	4	5	6	7	8	9	M	C								

MANUFACTURER'S NAME & ADDRESS				MANUFACTURING QUALITY PLAN (FOR REFERENCE)										PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T)			
ITEM:				QIP NO : PE-V0-426-501-A101		CONTRACT NO :		CONTRACTOR :		VENDOR'S QAP No :		REMARKS					
				REV : 0													
				DATE : MAR 2019													
SL. NO.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	TYPE PF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY								
1	4	3	4	5	6	7	8	9	M	C	N						
		backlash, rise in temp. after 2		Measurement			oil leakage, Noise	Report			10						
		Hrs. of running.					85 db at 1 Mtr.										
		reduction ration, backlash and contact pattern					Max. Temp. rise										
		dimensional conformity					40°C above amb										
D	a) Top block, bottom block		Major	Measurement	100%	Assembly drawing	Assembly drawing	Vendor insp.	P	V	V						
	b) Hook		Major	Chemical, heat treatment & Tensile, % elongation	100%	IS:1875		Report									
		i) Chemical composition, Heat treatment, Mechanical properties on integral test bar						Test Certificate , HT chart & Insp. Report	P	V	V						
		ii) UT on raw material of hook	Major	UT	100%	ASME sec-v	Annex-1 (Attached)		P	V	V						
		iii) Forging operation of hook	Major	Visual	100%	IS:5749 /IS:15560	IS:5749 /IS:15560		P	V	V						
		iv) Proof load test	Major	Mechanical	100%	IS:5749 /IS:15560	IS:5749 /IS:15560		P	W	V						
		v) UT & MPI after proof load test	Major	UT & MPI	100%	ASME sec - v	Annex-1 for UT &		P	W	V						
							No crack & linear										
							indication (For MPI)										
E	Rope drum assembly	Diemnsional conformity	Major	Measurement	100%	Component Drawing	Tolerance as per drg	Vendor insp	P	V	V						
								Report									
11	Electrical components																
a)	Motors (=< 50 KW)	make , type , rating, Routine test	Major	Review mfr's TC	100%	IS:325	IS 325/Mfr's T.C.	Mfr's T.C.	P	V	V			Refer Note 3.			
														For Motor above 50kW separate QP shall be followed			
b)	Brakes	Make , t type , rating , dia , IR, HV , Functional test /Routine test	Major	Review mfr's TC	100%	Appd drgs	Appd drgs	Mfr's T.C.	P	V	V						

MANUFACTURER'S NAME & ADDRESS			MANUFACTURING QUALITY PLAN (FOR REFERENCE)										PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T)			
ॐ ॐ ॐ ॐ ॐ ॐ ॐ ॐ ॐ			ITEM:		QP NO : PE-V0-426-501-A101		CONTRACT NO :		CONTRACTOR :		VENDOR'S QAP No :					
					REV : 0											
					DATE : MAR 2019											
SL.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	TYPE PF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY	REMARKS						
NO.																
1	4	3	4	5	6	7	8	9	D* **	10	11					
c)	Control panel	Overall diemnsions ,painting shade, Panel surface finish, sheet hickness	CR	functional & routine check	100%	Relevant drg & Generally confirm to IS : 3177 / App. Panle Drg. & BOM	Relevant drg. & IS : 3177 / App. Panle Drg. & BOM	Vendrs insp Report	✓	P	W	V	VFD Test Certificate to be submitted from appvd. Vendor for verification.			
d)	Pendent , switches	HV, IR,Functional	Major	Verification	100%	BOM/ Mfr. Catalogue	BOM/ Mfr. Catalogue	Mfr's T.C.	✓	P	V	V	Refer Note No. 4			
e)	Limit switches	HV, IR & Functional	Major	Verification	100%	Approved drawings	Approved drawings	Mfr's T.C.	✓	P	V	V				
f)	Trailing cable, Power	Make , type , rating ,Routine & acceptance test	Major	Verification	100%	IS: 9968	IS: 9968	Mfr's T.C.	✓	P	V	V				
g)	Control Cable & DSL Transformer	insulation resistance values make rating , routine test	Major	visual	100%	IS 1554-Part-1	IS 1554-Part-1	IR		P	V	V				
h)	SFU, MCCB,MCB, Contactors, DSL, relays, fuses, resitance bank	make, t ype , rating size, functional, continuity check	Major	visual	100%	Appd drg	Appd drg	IR		P	V	V				
i)	VVVF drives	make , type , rating, routine test	Major	visual	100%	Appd drg	Appd drg	IR		P	V	V				
j)	Anti collision devices , cable gland , lugs , r ectifier, indicating lamps, terminal blocks, load cell.	make , type	Major	visual	100%	Appd drg	Appd drg	IR		P	V	V				
12	Bought our Items															
a)	Wire rope	Visual , tensile	Major	Type, grade, dia breaking strenth	100%	IS:2266	IS:2266	T.C.	✓	P	V	V				
b)	Other Items	Dimensional conformity	Major	Review TC	100%	Relevant Drg.	Relevant Drg.	Vendor Confirmation		P	V	V				
c)	Bearing	Type & Size	Major	Verification		Appd drg/Mfr's catalogue	Appd drg/Mfr's catalogue		✓	P	V	V				

		MANUFACTURER'S NAME & ADDRESS		MANUFACTURING QUALITY PLAN (FOR REFERENCE)						PROJECT : 1X660 MW PANKI EXTN PACKAGE : DOUBLE GIRDER CRANES (UPTO 100T)	
				ITEM:		QIP NO : PE-V0-426-501-A101	CONTRACT NO :				
						REV : 0	CONTRACTOR :				
						DATE : MAR 2019	VENDOR'S QAP No :				
SL. NO.	COMPONENTS & OPERATION	CHARACTERISTICS	CLASS	TYPE PF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY	REMARKS	
1	4	3	4	5	6	7	8	9	M	C	N
17	Mandatory spares	Make, type, rating	Major	Verification	100%	Approved drgs/doc	Approved drgs/doc	Vendor's Report	P	W	W
		Note 1 : Original TCs / Photocopies certified in original by mill shall be furnished for review. Test in absence of correlated TCs Check test shall be carried out from each plate/ bar for above 10 mm thk., certificates shall be offered for review at the time of stage inspection of components / assembly. Supplier shall ensure that pitted material is not used.									
		Note 2 : X-Ray to be taken for thickness upto 19 mm and Gamma Ray for thickness above 19 mm. If Gamma Ray is used for lower thickness slow speed film like D2 or equivalent which gives enough readable and interpretable film quality to be used for clarity. All NDT shall be carried out by Qualified Level II personnel.									
		Note 3 : For Motors of 30 KW rating and above Routine Test will be witnessed by BHEL and Type Test Certificate will be reviewed for validity and conformance. For below 30 KW rating routine tests to be witnessed by supplier of crane and Type test reviewed for validity and conformance. Photocopies of Type Test certificates are acceptable but shall be duly authenticated by Manufacturer.									
		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 : Acceptance norms for UT (Normal probe to be used of not less than 2 MHz frequency) : Following defects are not acceptable:/ Vendor's UT Procedure approved by BHEL may also be used. (i) Cracks, flakes, seams and laps (ii) Defects giving indications larger than 4 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 4 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 20%. (iv) Defects giving indications of 2 to 4 mm diameter equivalent flaw separated by a distance less than four time the size of the larger of the adjacent flaws. For hooks, for carrying out UT on the areas where there is loss of back wall echo due to geometry, the calibration shall be done on blocks of same material of similar thickness having Flat Bottom holes of required size as given above									
		LEGEND :									
		D * RECORDS IDENTIFIED WITH 'TICK' (✓) SHALL BE ESSENTIALLY									
		INCLUDED BY CONTRACTOR IN QA DOCUMENTATION									
		** M : MANUFACTURER/SUBCONTRACTOR									
MANUFACTURER/		CONTRACTOR									
		C: BHEL-CQS/THIRD PARTY									



TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN

SPECIFICATION No: PE-TS-426-501-A101

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

SECTION-I

REV. 00

DATE: MAY 2019

CUSTOMER SPECIFICATION

PART OF SPECIFICATION PE-TS-426-501-A101

- 28.2.6 The EOT cranes shall of the double girder plate box type construction.
- 28.2.7 The EOT cranes shall be designed as per Class M5 for mechanical and structural components and Class M5 for all electrical components IS: 807, IS 3177.
- 28.2.8 ~~The turbine building EOT crane shall be able to be operated both from cabin located on the crane and pendant push button station hanging from the crane. Radio remote control shall also be provided as additional feature for Turbine hall EOT crane .~~ The other cranes EOT crane shall be operated from pendant push button station hanging from the crane.
- 28.2.9 Creep Speed for EOT Cranes: 10% of main speed shall be creep and shall be provided for all motions of the EOT cranes viz. long travel, cross travel, auxiliary hoist and main hoist.
- 28.2.10 Layout Considerations: The span of EOT cranes shall be derived based on the building layout with considerations to clearances and hook approach.
- Access walkway of minimum 800 mm width with safety handrails shall be provided along the full span length of the cooling water building crane.
- 28.2.11 Other Features
- The hook for hoists shall be plain shank type swiveling hook with locking device.
- The EOT cranes shall be designed to operate with 125% of rated load without any permanent deformation.
- The EOT cranes are designed with a maximum deflection of 1/900 of crane span at rated load.

- 28.4 EOT CRANES FOR BOILER FEED PUMP (if envisaged)
- 28.4.1 one (1) no of Electrically operated travelling cranes for each unit with associated auxiliaries, alongwith electrical equipment, control & instrumentation as required and specified shall be provided in the BC bay for erection and maintenance of Boiler feed pump and their auxiliaries. The capacity of each crane shall be 25% over and above the heaviest component/equipment to be handled (including lifting beam and slings etc., if provided) or 25 Tonne whichever is higher.
- 28.4.2 The EOT crane shall be pendent operated. The power shall be supplied from a single electrical power supply point at a suitable location on the operation floor of pump house.
- 28.4.3 The design code for EOT crane shall be IS: 3177 latest edition. However, the speed for the various motions shall be as follows:
- | | | |
|-------------------------------|---|-----------|
| Main hoist | - | 1.6 m/min |
| Trolley Travel (Cross Travel) | - | 4.0 m/min |
| Crane Travel (Long Travel) | - | 8.0 m/min |
- 28.4.4 Creep speed drives shall be provided for all the motions viz. bridge motion, trolley motion and hoist motion. This shall be 10% of the rated speeds. (Creep speed to be achieved ~~through pony motor and planetary gear box or~~ through variable voltage variable frequency (VVVF) system. Hoist brake shall not be used for this motion).
- 28.4.5 The crane shall be electrically operated, overhead travelling type. Design and duty of crane structure, main hoist, cross travel. Long travel shall be in accordance with class M5 of IS:3177 (latest edition) and shall be suitable for indoor operation.
- 28.4.6 The crane shall be complete with trolley and truck, wheels and axles, Drive mechanisms, Hoisting Drums, Brakes, Creep Speed Arrangement, Lifting tackles, Buffers Electric Motors, Controls, Switch Board and cabling, horns, warning lights, Limit switches etc. Any item not mentioned herein but required to make the system complete for the satisfactory performance of the crane shall also be included.
- 28.4.7 The main hoist, trolley travel and crane travel for each movement shall be motor driven. Proper allowance shall be made for impact and wear in the design of the crane and in no case shall the factor of safety in any part be less than six (6), as per IS: 3177 based on the ultimate strength of the materials used at design duty. The design duty of crane structure, main hoist, cross travel and long travel shall conform to class M5 of the Indian Standard IS: 3177 (latest edition) or superior. The crane as a whole shall comply with the Indian Standard IS: 3177 / IS: 807 or approved equivalent international standard (latest edition).
- 28.4.8 Mechanical and Electrical equipment of each crane shall be of simple robust design, easy for correction adjustment, readily accessible for maintenance and elegant in appearance. All steel used in the crane shall be tested to requirements.

- 28.4.9 The hoist motors shall be provided with electro-magnetic brakes as well as Electro Hydraulic Thrust brakes. Electro - Hydraulic Thrust brakes shall be provided for cross travel & long travel.
- 28.4.10 2 X 100 % Brake shall be provided for each motion. Each brake for hoisting motion, cross travel, long travel etc., shall be designed as per following:
- 28.4.11 Brakes to be as per IS 3177. The Capacity of hoisting motion brakes to be 150% of torque transmitted to the brake drum with full load and that of cross travel and long travel to be 125% of motor rated torque before deaerating.
- 28.4.12 Safe means of access shall be provided and to every place of crane where examination/maintenance of any component is involved. A platform shall extend to full length of the crane bridge on both sides of the bridge girder. The platform shall be made of checkered Steel plate. A double tire hand -rail of height 1100 mm shall be provided along the outer edge of the platform and 75mm high toe-guards shall be provided all along the platforms and wherever else required from safety consideration. The width of platform shall not be less than 800mm in width and Guard rails shall be provided on the crab side of the bridge platform.
- 28.4.13 LADDERS : Necessary access ladders shall be provided for access on to crane bridge platform from the gantry girder level, from crane bridge platform to trolley platform and from operating floor of pump to gantry girder level.
- 28.4.14 The lifting tackle shall consist of a safety type lower pulley block, hook, necessary sheave and flexible steel wire ropes. The lower block sheaves and ropes shall be of adequate design and size to handle the specified loads. The hooks shall be of forged steel. The main hook shall be of shank type conforming to IS:15560 (latest edition). The factor of safety for the rope shall not be less than six (6). The sheaves shall be of heavy duty with deep flanges made of cast steel and shall be properly grooved to fit the rope and adequately guarded.
- 28.4.15 Each crane shall be controlled individually for all its motions from the control pendent panel. Each crane shall have a permanent inscription of English on each side, readily visible from the ground level, stating the safe working loads in tonnes for both the hooks, year of manufacture, crane serial number and manufacturer's name.
- 28.4.16 The vertical deflection of crane girder shall not exceed 1/900 of the span, as per IS: 807. The girder shall be of box type and construction shall ensure non-accumulation of water/oil inside the box.
- 28.5 Other EOT Cranes
- 28.5.1 The EOT cranes for all other areas indicated in clause 28.1.3 above shall meet all the requirements indicated in clause 28.4 above.
- 28.5.2 The EOT crane in CW pumphouse shall be provided with auxiliary hoist of 5 T capacity.

- 28.6 Electrical Requirements
- 28.6.1 Electrical equipment shall be adequately rated to permit simultaneous operation of any combination of motions of the crane for its duty service.
- 28.6.2 Motors
- 28.6.2.1 Three phase Squirrel Cage Induction motors to be operated from VFD system shall be suitable for speed range and torque without exceeding temperature rise limits as specified elsewhere in this specification. These motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for Inverter duty.
- 28.6.2.2 Motors shall conform to latest revision of IS 325, IS 3177 and motor subsection of this specification.
- 28.6.2.3 Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.
- 28.6.2.4 Motors shall suit the duty class S4, cyclic duration factor 60% and 300 starts per hour and shall be suitable for VVF operation. Motor pull out torque shall not be less than 2.75 times/ rated torque. Motor shall have class F insulation temperature rise limited to class B and enclosures shall conform to the degree of protection IP-55.
- 28.6.2.5 All motors shall be capable of the following:
- Operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.
 - Withstand 120% of rated speed for two minutes.
 - Current shall not exceed 6 times full load current for creep speed motor.
 - Withstanding the stresses imposed if started at 110% rated voltage.
 - Start with rated load and accelerate to full speed with 80% rated voltage at motor terminals.
 - The locked rotor motor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 3 seconds for motors upto 20 seconds starting time.
 - Maximum torque shall not be below 200% of full load torque.
- 28.6.2.6 Each motor more than 30 KW rating shall be provided with space heater. All electrical equipment accessories and wiring shall have tropical protection.
- 28.6.2.7 The crane(s) shall be furnished complete with all electrical equipment, accessories, like drive motors with VVF drives, conductors, insulators, protective & operating devices, cables, current collectors, all protective devices, anti collision limit switches, mechanical overload and protection for electrical faults etc
- 28.6.2.8 The VVF drive control shall be used for control of each motion. The VVF drive shall be equipped at least with 1024 pulse in/crd, droop control for synchronization and crane software. The rating of VVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.

28.6.3 Controls

- i) Speed control of EOT crane shall be through Variable Voltage Variable Frequency System (VVVF) with minimum 6 (six) pulse design.
- ii) Necessary input & output devices to be provided to reduce harmonics, as per IEE519, at supply side of the drive at the switchgear.
- iii) All necessary protections e.g. Input Phase Loss, Earth Fault, Over Voltage, Output Short Circuit, Load Loss, Input Transient Protection, Overload etc to be provided.
- iv) VVVF system shall be capable of generating suitable starting torque (upto 400% typical) with / without encoder, however starting current shall not exceed 150% of the rated torque.
- v) VVVF system shall be capable of withstanding upto 50 deg C ambient temp without derating
- ~~vi) Provision for controlling the motion from operator cabin as well as remote control shall be available.~~
- vii). Squirrel cage Induction motor with VPI insulation shall be provided With VVVF system.
- viii) Master controller - Desk type having following features.
 - (i) Five speed control points in each direction of hoist motion.
 - (ii) Four speed control points in each direction of bridge and trolley motion.
 - (iii) Release of operator's hand from the controls shall stop motion and set brakes automatically.
- ix) Protective Panel Provided with isolating switch, power contactor control and indication to switch ON/OFF power to starter panels, control and lighting transformer
- x) Separate VVVF system panels to be provided for CT, LT and hoist motion (main and auxiliary drives).
 - a) Contactors : AC 4 duty for reversing application AC 3 duty for non reversing application
 - b) Switches: AC 23 for motor application, AC 22 for other application.
 - c) Fuses: HRC

- d) Overload relay : Temperature compensated, bimetallic with single phasing preventor.
- xi) Panel shall be fabricated out of 1.6 mm thick rolled sheet steel. IP 52 degree of protection. Paint shade shall be RAL 9002 for front & rear and RAL 5012 for side covers. Space heaters to be provided.

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28.6.5 Power Supply

- (a) Incoming numbers: Employer shall provide two (2) numbers 415 volts, 3 phase, 4 wire supply at operating floor ~~near A-row column~~ at centre of bay length. Bidder shall provide a changeover switch in enclosure to receive above power supply.
- (b) Down shop Lead (DSL):
- (i) Shall conform to IS : 282 and shall be sized to
- Cater to all cranes working simultaneously with 40% cyclic duration factor for load.
 - Limit voltage drop at motor terminals within 2% at extreme positions.
- (ii) DSL shall be sized with a margin of 10% over oad requirement.
- (iii) Protective cover over DSL to be provided.
- (iv) Two (2) numbers isolating switches in enclosure shall be provided at extreme ends of operating floor for disconnecting supply to DSL while maintaining the crane.
- (v) DSL shall be located on 'A' -row side for Turbine hall EOT crane..
- (c) Transformers
- Dry type, with insulation class B or better. Following transformers shall be provided.
- (i) Control Transformers : 2x100%, 415V / 110V
- (ii) Lighting Transformers : One 415V/240V
- (iii) Hand lamp : One 415V/24V

28.6.6 Illumination

HPSV lamps under the bridge. Florescent lamp over the bridge and inside the cabin.

28.6.7 CABLES

- (a) EPR insulated, copper conductor trailing cables, as per IS:9968, on the bridge.
- (b) Extruded PVC insulated, copper/Aluminium conductor, 1100 Volt grade power cables. This shall include cable lengths between changeover switch & DSL and isolating switch & DSL.
- (c) Extruded PVC insulated, copper conductor 1100 volt grade control cables. Mechanical overload protection - to be provided for hoist mode.

28.7.0 MAXIMUM SPAN / DEPTH RATIO FOR GIRDER:

- (a) Plate girders : 18
- (b) Lattice girders : 12

28.8.0 Material

- (i) Structural steel plates : Mild steel, grade 'B' of IS 2062 in 100% killed rolled section normalised and ultrasonically tested quality or high strength steel of IS 8500 as appropriate
- (ii) Nuts & Bolts : As per IS:1363, IS:1364 and IS:1367. High Tension Friction grip bolts as per IS : 3757. High Tension Friction grip nuts as per IS : 6623.
- (iii) Electrodes : Radiography quality, covered electrodes with heavy covering as per IS : 814 and relevant requirements of ASME Sec. IX and IIC. Bare Electrodes as per IS:7280 and flux wire combination as per IS : 3613.
- (iv) Chequered plates : IS: 3502 (Minimum 6 mm thick O/P)
- (v) Hand rail pipes : 32 mm NB Medium class of IS : 1161 having top and bottom rail at height of 1050 mm and 600 mm and vertical post spacing not exceeding 1500 mm with provision of kick plate(100 mm high and 6 mm thick).
- (vi) Crane Rails : As per IS : 3443 Grade 50 C 12.

28.9.0 Minimum thickness of Structure Members:

- (a) Load Carrying members : 8 mm
- (b) Tubes with both ends sealed : 4.9 mm (6 SWG)
- (c) Tubes with unsealed ends : 8 mm
- (d) Chequered plate : 6 mm O/P

CHAPTER 5 : GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

This part covers technical requirements, which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.

2.0 BRAND NAME

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Owner to determine that the products proposed are equivalent or superior to those named.

3.0 BASE OFFER & ALTERNATE PROPOSALS

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Owner. Sufficient amount of information for justifying such proposals shall be furnished to Owner along with the bid to enable the Owner to determine the acceptability of these proposals.

4.0 COMPLETENESS OF FACILITIES

4.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.

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

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

5.0 Codes & Standards

5.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:



- (a.) Bureau of Indian Standards (BIS)
- (b.) Indian Electricity Act (2003)
- (c.) Indian Electricity Rules
- (d.) Indian Explosives Act
- (e.) Indian Factories Act and State Factories Act
- (f.) Indian Boiler Regulations (IBR)
- (g.) Regulation of Central Electricity Authority
- (h.) Regulations of the Central Pollution Control Board, India
- (i.) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- (j.) Pollution Control Regulations by Department of Environment, Government of India
- (k.) State Pollution Control Board.
- (l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
- (m.) Explosive Rules, 1983
- (n.) Petroleum Rules, 1976,
- (o.) Gas Cylinder Rules, 1981
- (p.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
- (q.) Workmen's Compensation Rules, 1924
- (r.) Rules for Electrical installation by Tariff Advisory Committee (TAC) and appropriate Electrical Inspectorate.
- (s.) Owner's Safety Policy
- (t.) Any other statutory codes / standards / regulations, as may be applicable.

5.2 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

- (a.) British Standards (BS)
- (b.) Japanese Industrial Standards (JIS)
- (c.) American National Standards Institute (ANSI)
- (d.) American Society of Testing and Materials (ASTM)
- (e.) American Society of Mechanical Engineers (ASME)
- (f.) American Petroleum Institute (API)
- (g.) Standards of the Hydraulic Institute, U.S.A.
- (h.) International Organisation for Standardization (ISO)
- (i.) Tubular Exchanger Manufacturer's Association (TEMA)
- (j.) American Welding Society (AWS)
- (k.) Cooling Tower Institute (CTI)
- (l.) National Electrical Manufacturers Association (NEMA)
- (m.) National Fire Protection Association (NFPA)
- (n.) International Electro-Technical Commission (IEC)
- (o.) Expansion Joint Manufacturers Association (EJMA)
- (p.) Heat Exchange Institute (HEI)
- (q.) IEEE standard
- (r.) JEC standard

5.3 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish



specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

- 5.4 As regards highly standardized equipments such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.
- 5.5 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
- 5.6 Two (2) English language copies of all-national and international codes and/or standards used in the design of the plant, equipment, civil and structural works shall be provided by the Bidder to the Owner within two calendar months from the date of the Notification of Award.
- 5.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.
- 6.0 EQUIPMENT FUNCTIONAL GUARANTEE
- 6.1 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.
- 6.2 The functional guarantees of the equipment under the scope of the Contract shall be as per "Chapter 8 - Functional Guarantee & LD", Volume-II. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.
- 6.3 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.
- 7.0 DESIGN OF FACILITIES / MAINTENANCE & AVAILABILITY CONSIDERATIONS
- 7.1 Design of Facilities
- 7.1.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.
- 7.1.2 The Bidder shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the



rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.2 Maintenance and Availability Considerations

7.2.1 Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

7.2.2 Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.

7.2.3 Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

7.2.4 Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

8.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.1 Plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

The Contractor shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

8.2 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I attached with Chapter 5, Volume-II.

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

8.3.1 Basic Engineering Documentation

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Plant Definition Manual within 4-6 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:-

- 1) System description of all the mechanical, electrical, control & instrumentation & civil systems.



- 2) Technology scans for each system / sub-system & equipment.
- 3) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
- 4) Optimization studies including thermal cycle optimization.
- 5) Sizing criteria of all the systems, sub-systems including various piping systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- 6) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- 7) Operation Philosophy and the control philosophy of the Main Plant and other plants.
- 8) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in native (Word, Excell, ACAD etc) in the form of CD discs to the Owner for engineering of areas not included in Bidder's scope.
- 9) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.
- 10) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.

After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

8.3.2 Detailed Engineering Documentation

- 1) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
- 2) Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.
- 3) Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start-up.
- 4) Piping isometric, composite layout and fabrication drawings.
- 5) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.
- 6) Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.



- 7) Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.
- 8) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
- 9) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.
- 10) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- 11) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- 12) Model Studies/ CFD analysis for ESP, CW sump etc and furnishing report with recommendations.
- 13) Characteristic Curves/ Performance Correction Curves and thermal design calculations for Cooling Tower.
- 14) Composite Water Balance for total Plant.
- 15) Hydraulic calculation/profile for Water Treatment Plant.
- 16) Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.
- 17) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- 18) Protection systems diagrams and relay settings. Load Flow study.
- 19) Interconnection diagrams.
- 20) Cable routing plan.
- 21) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
- 22) Alarm and annunciation list and alarms & trip set points.
- 23) Sequence and protection interlock schemes.
- 24) Type test reports and power system stability study report.
- 25) Control system configuration diagrams and card circuit diagrams and maintenance details.



- 26) Detailed software manuals & source software listing.
- 27) Detailed flow chart for digital control system.
- 28) Mimic diagram layout.
- 29) Civil Task drawings (for the Engineering by Owner), Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- 30) Model study reports wherever applicable.
- 31) Functional & guarantee test procedures and test reports.
- 32) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- 33) Documentation in respect of commissioning as listed out elsewhere in this specification.

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

8.3.2 Instruction Manuals

The Bidder shall submit to the Owner, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Owner the Instruction Manuals shall be submitted as indicated in Annexure-IV. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Owner. The Instruction Manuals shall comprise of the following.

A) Erection Manuals

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

- 1) Erection strategy.
- 2) Sequence of erection.
- 3) Erection instructions.
- 4) Critical checks and permissible deviation/tolerances.
- 5) List of tool, tackles, heavy equipments like cranes, dozers, etc.
- 6) Bill of Materials
- 7) Procedure for erection.



- 8) General safety procedures to follow during erection/installation.
- 9) Procedure for initial checking after erection.
- 10) Procedure for testing and acceptance norms.
- 11) Procedure / Check list for pre-commissioning activities.
- 12) Procedure / Check list for commissioning of the system.
- 13) Safety precautions to be followed in electrical supply distribution during erection

B) Operation & Maintenance Manuals

- a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

- b) The arrangement and contents of O&M manuals shall be as follows :

- 1) Chapter 1 - Plant Description :

To contain the following sections specific to the equipment/system supplied

- i.) Description of operating principle of equipment / system with schematic drawing / layouts.
- ii.) Functional description of associated accessories / controls. Control interlock protection writes up.
- iii.) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).
- iv.) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.
- v.) Design data against which the plant performance will be compared.
- vi.) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.
- vii.) Identification system adopted for the various components, (it will be of a simple process linked tagging system).



viii.) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation:

To contain the following sections specific to the equipment supplied

- i.) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.
- ii.) Limiting values of all protection settings.
- iii.) Various settings of annunciation/interlocks provided.
- iv.) Start-up and shut down procedure for equipment alongwith the associated systems in step mode.
- v.) Do's and Don'ts related to operation of the equipment
- vi.) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.
- vii.) Parameters to be monitored with normal value and limiting values.
- viii.) Equipment isolating procedures.
- ix.) Trouble shooting with causes and remedial measures.
- x.) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.
- xi.) Routine Operational Checks, Recommended Logs and Records
- xii.) Change over schedule if more than one auxiliary for the same purpose is given.
- xiii.) System/plant commissioning procedure.
- xiv.) Preservation procedure on long shut down.

3) Chapter 3.0 - Plant Maintenance

To contain the following sections specific to the equipment supplied

- i.) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.
- ii.) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment
- iii.) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc



- iv.) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.
 - v.) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out
 - vi.) Overhauling schedules linked with running hours/calendar period alongwith checks to be done
 - vii.) Long term maintenance schedules
 - viii.) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling
 - ix.) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement
 - x.) Tolerance for fitment of various components
 - xi.) Details of sub vendors with their part no. in case of bought out items
 - xii.) List of spare parts with their Part No, total population, life expediency & their interchange ability with already supplied spares to OWNER.
 - xiii.) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.
 - xiv.) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares
 - xv.) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.
- 8.3.2.2 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.
- 8.3.2.3 If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O&M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.
- 8.3.3 Plant Handbook and Project Completion Report



8.3.3.1 Plant Handbook

The Bidder shall submit to the Owner a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

- 1) Design and performance data.
- 2) Process & Instrumentation diagrams.
- 3) Single line diagrams.
- 4) Sequence & Protection Interlock Schemes.
- 5) Alarm and trip values.
- 6) Performance Curves.
- 7) General layout plan and layout of main plant building and auxiliary buildings.
- 8) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.3.3.2 Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.3.4 Drawings

- a) i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.
- ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-VI (GTR)-Vol-II.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

- iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per Annexure-VI (GTR), Vol-II.
- iv) The completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to Employer,



along with the design review software (network ready) which shall include interference check, walk-through animation, simulation, visual effect, photo realism etc. loaded on a server with four (4) work stations (latest configuration for server & workstation) with one A4 size colored laser printer and one A0 size colored plotter. The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer.

The requisite hardware and software shall be supplied and commissioned by the Contractor at Employer's Head Office at Lucknow & Site Office at Panki as per mutually agreed schedule.

All softwares provided shall necessarily include the cost for perpetual license(s) for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three (3) years after warranty/guarantee period.

- b) All documents/text information shall be in latest version of MS Office or MS Excel as applicable.
- c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.
- d) Each drawing submitted by the Contractor (including those of sub vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- e) The drawings submitted by the Contractor (or their subvendor) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.
- f) The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- g) Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature



- h) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.
- i) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.
- j) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer.
- k) However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.
- l) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
- m) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
- n) As Built Drawings
After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to "as built" conditions in requisite number.
- o) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall



not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/documents for the same.

- p) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.
- q) All engineering data submitted by the Bidder after final process including review and approval by the Project Manager/Owner shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

8.4 Engineering Information Submission Schedule

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

- a) Information that shall be submitted for the approval of the Owner before proceeding further, and
- b) Information that would be submitted for Owner's information only.

The Master Drawing List (MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.5 Engineering Progress and Exception Report

8.5.1 Report giving the status of each engineering information including

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



- b) Drawings which were not submitted as per agreed schedule including those for revision after commenting last revision .
- 8.5.2 The draft format for this report shall be furnished to the Owner within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the Owner.

8.6 Engineering Co-ordination Procedure

- 8.6.1 The following principal coordinators will be identified by respective organizations at time of award of contract:

Project Manager (UPRVUNL EC):

Name :

Designation :

Address

a) Postal :

b) Telegraphic /e-Mail :

c) FAX : TELEPHONE (Land & Mobile):

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic /e-Mail :

c) FAX : TELEPHONE(Land & Mobile) :

- 8.6.2 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.6.3 Contractor's/Vendor's Drawing Submission and Approval Procedure:

- a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for OWNER'S information/ interface and or review and approval are referred by the general term "drawings".
- b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Owner before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.
- c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.
- d) Owner shall intimate the contractor, OWNER drawing number procedure. Vendor, thereafter, shall indicate OWNER drawing number in MDL and in subsequent Submission of drawing, in the space provided for this purpose in



title plate, in addition to his own drawing number, if any.

- e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/ documents for the same.
- f) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.
- g) The Contractor shall submit adequate prints of drawing / data / document for Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNER and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories/action:

CATEGORY/Action - 1 : Distributed
CATEGORY/Action - 2 : Approved

CATEGORY/Action - 3 : Approved, subject to incorporation of comments/ modification as noted. Forward final drawing Resubmit revised drawing incorporating the comments

CATEGORY/Action - 4 Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments

CATEGORY/Action - 5: Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted in accompanying memo.

CATEGORY/Action - 6 : For information and records.

- h) Contractor shall resubmit the drawings marked/stamped under Category/Action 3,4 & 5 within two(2) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall



bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (e.g. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Owner's review and approval. Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Owner shall review only such revised portion of documents.

- i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to OWNER for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- j) It shall be the responsibility of the Contractor/ Vendor to get all the drawings approved as the case may be and complete the engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.
- l) These comments will be taken care by the contractor while submitting the revised drawing.
- m) The contractor shall use a single transmittal for drawings Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

9.0 Technical Co-Ordination Meetings

9.1 The Bidder shall be called upon to organize and attend monthly Design/ Technical Co-ordination Meetings with the Owner / Owner's representatives / OWNER Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

9.2 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owner as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the Owner shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.



- 9.2.1 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
- 9.2.2 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
- 9.3 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.
- 10.0 Design Improvements
- The Owner or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.
- If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 11.0 Equipment Bases
- A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.
- 12.0 Protective Guards
- Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.
- 13.0 Lubricants, Servo Fluids and Chemicals
- 13.1 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.
- 13.2 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.

14.0 Lubrication & Chemicals

Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

14.1 Chemicals for Water System

Bidder's scope include Chemical required for complete water system up to final handing over EPC package and further two (2) months plant operational requirement.

15.0 Material of Construction

All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.

16.0 Rating Plates, Name Plates & Labels

16.1 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.

16.2 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.

16.3 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

16.4 Items of plant such as valves, which are subject to handling, shall be provided with engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

16.5 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.



- 16.6 Valves, steam traps and strainers shall be identified by Owner's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.
- 16.7 Safety and relief valves shall be provided with the following:
- Manufacturer's identification.
 - Nominal inlet and outlet sizes in mm.
 - Set pressure in Kg/cm² (abs).
 - Blowdown and accumulation as percentage of set pressure.
 - Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.
- 16.8 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
- 16.9 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system
- 17.0 Tools and Tackles
- The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.
- The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Owner.
- 18.0 Welding
- 18.1 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be per formed by others the requirements shall be submitted to the Owner in advance of commencement of erection work.
- 19.0 Colour Code for all Equipments/ Pipings/ Pipe Services
- 19.1 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.
- 20.0 Protection and Preservative Shop Coating



20.1 Protection

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a non-metallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Chapter 9, Volume II.

20.2 Preservative Shop Coating

20.2.1 All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.

20.2.2 Transformers and other electrical equipments if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

20.3 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.

20.4 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

20.5 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

20.6 Painting for Civil structures shall be done as per relevant part of technical specification.

21.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points, as necessary. Such programs shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA program shall be generally in line



with ISO-9001/IS-14001. A quality assurance program of the contractor shall generally cover the following:

- a) His organization structure for the management and implementation of the proposed quality assurance program
- b) Quality System Manual
- c) Design Control System
- d) Documentation and Data Control System
- e) Qualification data for bidder's key personnel.
- f) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- g) System for shop manufacturing and site erection controls including process, fabrication and assembly.
- h) Control of non-conforming items and system for corrective actions and resolution of deviations.
- i) Inspection and test procedure both for manufacture and field activities.
- j) Control of calibration and testing of measuring testing equipment.
- k) System for Quality Audits.
- l) System for identification and appraisal of inspection status.
- m) System for authorising release of manufactured product to the Owner.
- n) System for handling, storage and delivery.
- o) System for maintenance of records, and
- p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as Annexure-I and Annexure-II respectively.

22.0 General Requirements - Quality Assurance

22.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule



- of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.
- 22.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. CD or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.
- 22.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 22.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.
- 22.5 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 22.6 All material used for equipment manufacture including casting and forging 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.
- 22.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the format enclosed at Annexure-V. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
- 22.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.



- 22.9 All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.
- 22.10 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.
- 22.11 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 22.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 22.13 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 22.14 No welding shall be carried out on cast iron components for repair.
- 22.15 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 22.16 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 Society of non-destructive examination). NDT shall be recorded in a report, which includes details 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.
- 22.17 All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.
- 22.18 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.
- 22.19 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's



purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. 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, quality plans and delivery conditions shall be furnished to the Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.

22.20 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

22.21 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

22.22 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner 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 Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.23 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.24 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.

22.25 Environmental Stress Screening

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following

1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.



OR

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two number or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

2) Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

22.26 The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner 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 stage.

23.0 QA Documentation Package

23.1 The Bidder shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (✓) mark.



- 23.1.1 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier 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.

- 23.2 Typical contents of QA Documentation are as below:-

- a) Quality Plan
- b) Material mill test reports on components as specified by the specification and approved Quality Plans.
- c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- e) Heat Treatment Certificate/Record (Time- temperature Chart)
- f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- g) CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
- h) Certificate of Conformance (COC) wherever applicable.
- i) MDCC

- 23.3 Similarly, the Bidder 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, prior to commissioning of individual system.

- 23.4 Before despatch / commissioning of any equipment, the Supplier 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 supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
- b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality



document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

- c) If a decision is made despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

23.5 Transmission of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Quality Assurance Department (@ Head Office) and other set to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.0 Project Manager's Supervision

24.1 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

24.2 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

- a) Interpretation of all the terms and conditions of these documents and specifications:
- b) Review and interpretation of all the Bidder's drawing, engineering data, etc:
- c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :
- d) Inspect, accept or reject any equipment, material and work under the contract.
- e) Issue certificate of acceptance and/or progressive payment and final payment certificates
- f) Review and suggest modifications and improvement in completion schedules from time to time, and



- g) Supervise Quality Assurance Programme implementation at all stages of the works.

25.0 Inspection, Testing and Inspection Certificates

25.1 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.

25.2 The Project Manager or his duly authorized representative and/or an outside inspection agency acting on behalf of the Owner shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.

25.3 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

25.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

25.5 When the factory tests have been completed at the Bidder's or sub-Bidder's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.

25.6 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorized representatives to carry out effectively such tests on the equipment in accordance with the



- Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.
- 25.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.
- 25.8 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03 of this chapter, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 25.9 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.
- 25.10 Associated document for quality assurance programme:
- 25.10.1 List of items requiring quality plan and sub supplier approval. (Annexure-III).
- 25.10.2 Status of items requiring Quality Plan and sub supplier approval (Annexure-IV)
- 25.10.3 Field Welding Schedule (Annexure-V).
- 25.10.4 Manufacturing Quality Plan (Annexure-I).
- 25.10.5 Field Quality Plan (Annexure-II).
- 25.11 TESTING OF MAJOR DESIGN FEATURES OF I&C SYSTEM:
- The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within four months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design & finalization of important engineering documents like configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfil the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following
- A) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.
 - B) Loop reaction time for sample loops/ logics
 - C) SOE functionality tests
 - D) Server changeover
 - E) Various response times, having serious implication on operation & maintenance philosophy



- F) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.
- G) Unified HMI for DDCMIS

The results of the above tests, after its acceptance by the Owner, shall be properly documented and submitted to Owner.

25.12 DEMONSTRATION OF APPLICATION ENGINEERING

2.12.1 Based on UPRVUNL inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following

i) Logics / Loops:

- a) Drive logics implementation for each type of binary drive along with its display in HMI.
- b) Sequence implementation along with its display in HMI.
- c) Single non-cascade controller implementation.
- d) Cascade loop implementation.
- e) Master slave implementation with different slave combination.
- f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable

ii) HMI Functions:

- a) LVS Annunciation.
- b) Graphics.
- c) HSR
- d) Logs/Reports.
- e) Calculations (Basic & Performance Calculations).

25.12.2 The above typical cases shall be finalized with the Owner through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on UPRVUNL inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by the Owner and demonstrate to Owner at Owner premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Owner premises & the results shall be documented as part of test report.

25.12.3 During the integrated testing at the Contractor's works, only sample checks shall be done by the Owner for the items covered in above application engineering demonstration.



26.0 PRE-COMMISSIONING, COMMISSIONING, TRIAL OPERATION, PERFORMANCE TEST

- 26.1 a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Owner and the Bidder for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- b) The Bidder's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.
- c) It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spars required for successful commissioning of all the equipment covered under the contract. Such a list shall be furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.
- d) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Owner six months prior to the respective implementations. The Owner will approve final verification of cleanliness.
- e) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.
- f) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.
- g) The Bidder during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at



the base load, peak load as well as lowest sustained operating condition as far as practicable.

26.1.1 Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain:

- a) Biodata including experience of the Commissioning Engineers.
- b) Role and responsibilities of the Commissioning Organisation members.
- c) Expected duration of posting of the above Commissioning Engineers at site.

26.2 Initial Operation / Trail Operation Test

- a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.
- b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

The Initial Operation Test shall be considered successful, if during the above period of initial operation, the 660MW unit shall generates a minimum of 451 million kWhrs*, as measured a generator terminals.

- c) The Initial Operation shall be considered successful, provided that each item/ part of the facility has operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.
- d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.
- e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.
- f) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications / repairs to the plant shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe



operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

(* - shall be appropriately adjusted for any generation loss attributable to Employer.)

26.3 Guarantee Tests

- a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test. Such test will be commenced, within a period of three (3) months after the successful completion of Initial Operations. Any extension of time beyond the above three (3) months shall be mutually agreed upon.
- b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.
- c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
- d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
- e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specification.

27.0 TAKING OVER

Upon successful completion of Initial Operations and all the tests (including all PG test) conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

28.0 TRAINING OF OWNER'S PERSONNEL

28.1 The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:



- a) Training for Steam Generator & ESP Equipment, TG & Auxiliaries and related equipments.
- b) Training for Electric Systems including VFD and Electric power supply system.
- c) Training for other SG/TG related C&I systems/equipments including training on Flame Monitoring System, Furnace and Flame Viewing System, Turbine Supervisory System (TSS) including vibration analyzer, vibration monitoring system axial shift, eccentricity measurements etc. for Main Turbine, BFP Turbine etc. Burner management study, control loop study, misc system for SG C&I, EHTC, Turbine stress control system, Turbine protection system, ATRS, instrumentation etc.
- d) Training for special packages for various PC based systems.
- e) Training for various C&I systems/equipment supplied includes the following:
 - i. DDCMIS - Human Machine Interface – Hardware & Operating System
 - ii. DDCMIS-Human Machine Interface System Engineering & Application Software.
 - iii. DDCMIS – Control System Hardware and Control system Application Software.
 - iv. DDCMIS – Operator Training: Use of the system at Works + at site.
 - v. DDCMIS – Specialized Network security.
- f) Training for power cycle piping/critical piping.
- g) Training for UPS systems Annunciation system, SWAS, PA system, flue gas analysers, CCTV and 24 VDC systems.
- h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.
- i) Details of training modules for Mechanical, Electrical and C&I systems are given at Annexure – VII,

The exact details, extent and schedule for training shall be as finalised during detailed engineering and shall be subject to Owner's approval.

- 28.2 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module as indicated in Annexure – VII. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc.
- 28.3 Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.



- 28.4 Four (4) man month and two (2) man month training for OWNER Engineering Personnel on the offered CFD modelling code for SG & ESP including alternative geometry modeling technique shall be provided.
- 28.5 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (Annexure – VII for O&M and Engineering) is indicative only. Owner reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.
- 28.6 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.
- 28.7 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's (within Employer's Country) it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 28.8 In case the training of Owner's personnel is arranged at the works of the manufacturer's (outside Employer's Country) it shall be noted that the all the expenses including travel, air fare, application processing fees, lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
- 28.9 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award.
- 28.10 In addition to above, the contractor shall also arrange for training of 30 Owner's Personnel at a running 660 MW unit on operation of power station, for a period of six (6) months. The training shall be conducted before commissioning of the unit. The lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same
- Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.
- 29.0 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION
- In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:
- a) Working platforms should be fenced and shall have means of access.
 - b) Ladders in accordance with Owner's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.
- 30.0 Noise level



The equivalent 'A' weighted sound pressure level measured at a height of 1.0 m above floor level in elevation and at a distance of one (1) meter horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

- a) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.
- b) Regulating drain valves in which case it shall be limited to 90 dBA.
- c) TG unit in which case it shall not exceed 90 dBA.
- d) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 85 dBA.
- e) Mill noise which will be limited to 85-90 dBA.

31.0 PACKAGING AND TRANSPORTATION

All the equipments & spares 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. Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

32.0 ELECTRICAL EQUIPMENTS/ENCLOSURES

All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.

33.0 Instrumentation and Control

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.



- 33.1 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm ²). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
c)	Draught	-	Millimeters of water column (mm wc).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (mmWcl).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15 deg.C
i)	Density		Grams per cubic centimeter.

- 33.2 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

- 33.3 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

34.0 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

35.0 SURGE PROTECTIONS FOR SOLID STATE EQUIPMENT

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates etc. shall be submitted by the Bidder.

36.0 Instrument Air System

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power



cylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

37.0 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

- a) Temperature test pockets with stub and thermowell.
- b) Pressure test pockets

38.0 SYSTEM DOCUMENTATION (DDCIMS)

The Bidder shall provide drawings, system overview & description, hardware/software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C&I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Owner during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I "Technical Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

38.1 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Owner.

39.0 MAINTENANCE MANUALS OF ELECTRONIC MODULES

The Contractor shall have to furnish two(2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further, the contractor shall furnish a set of operating manuals which should include block diagrams, make,



model/type, details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

40.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

40.1 The Power Plant will be developed based on the guidelines of the State Environmental Authorities and that of MoEF. Suitable provisions will be incorporated in the design of buildings, structures, and selection of equipment, so that there are no adverse effects due to emissions, noise, and contamination of soil, water and air.

40.2 One single flue stack of 275 meter will be provided for 660 MW unit for wider dispersion of pollutant as per environmental guidelines.

41.0 LIST OF CODES AND STANDARDS

←---	Indian Standards Title	-->	← International and international recognized Standards →
IS: 277	Galvanised steel sheets (plain or corrugated)		
IS: 655	Specification for metal air duct		
IS: 800	Code of practice for use of structural steel in general building construction 1-1952		BS 449:1969 BS 5950 ASA A57,
IS: 807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Association of Australia) DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960BS 1757:1951 BS 2573:part-I:1960		Draft Revision, A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev
IS:875	Code of practice for design loads (other than Canadaearthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)		National Building code of (1953)-Part-IV Design section 4.1



IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 BS 1740 :1965
IS:2825	Code for unfired vessels	
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water	
IS:1600	Code for practice for performance of constant speed IC Engines for general purpose	
IS:1601	Specification for performance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe April 1969.	API Standards 5L
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968
IS:2312	Propellant type Ventilation fans	
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) ASTM C 163-1964 (American Society of Testing and materials) ASTM C 167-1974 ASTM C 177-1963
IS:3354	Outline dimensions for electric lifts.	
IS:3401	Silica gel	
IS:3588	Specification for electrical axial	



	flow fans	
IS:3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diameter)	
IS:3677	Unbonded rock and slag wool for thermal insulation	
IS:3815	Point hook with shank for general engineering purposes	BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)
IS:3895	Specification for monocrystallines semiconductor rectifier cells and stacks	
IS:3963	Roof extractor unit	
IS:3975	Mild steel wires, strips and tapes for armouring cables	
IS:4503	Shell and tube type heat Exchanger	
IS:4540	Specification for monocrystallines rectifier assembly equipment	
IS:4671	Expanded polystyrene for thermal insulation purpose	
IS:4736	Hot dip zinc coating on steel tubes	
IS:4894	Centrifugal fans	
IS:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
IS:6392	Steel pipe flanges	BS 4504 : 1969
IS:6524 Part-I	Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
IS:7098	Cross linked Polyethylene insulated PVC sheathed	Standard No. 1 to IPCEA (USA) Pub.



	cables No. 5-66-524
IS:7373	Specification for wrought aluminium and aluminium sheet and strips
IS:7938	Air receivers for compressed air installation
ISO:1217	Displacement compressor-Acceptance test
ASHRAE-33	Methods of testing for rating of forced circulation air cooling and air heating coils.
ASHRAE-52-76	Air cleaning device used in general ventilation for removing particle matter.
ASHRAE-22-72	Method of testing for rating of water cooled refrigerant condensers.
ASHRAE 23-67	Methods of testing for rating of positive displacement refrigerant compressors.
ARI-450-6	Standard for water cooled refrigerant condensers.
ARI-550	Standard for centrifugal water chilling packages.
ARI-410	Standard for forced circulation air cooling and air heating coils
ARI-430/435 BS:848 (Part-1,2)	Central station AHU/Application of Central Station AHU Fans
BS:400	Low carbon steel cylinders for the storage & transport of permanent gases.
BS:401	Low carbon steel cylinders for the storage & transport of liquefied gases.
CTI Code ACT-105	Acceptance test code for Water Cooling Tower.
ANSI-31.5	Refrigerant piping
ASME-PTC- 23-1958	Atmospheric Water Cooling Equipment
AMCA A-21C	Test Code for air moving devices
API:618	Reciprocating Compressor for general refinery services.
HYDRAULIC INSTITUTE STANDARDS.	
HYDRANT SYSTEM MANUALS OF TAC.	
TAC MANUALS OF SPRAY SYSTEM	



(Part-II)	Calcined clay based.
IS: 1542	Specification for sand for plaster.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed bars for concrete reinforcement.
IS: 2062	Specification for steel for general structural purposes.
IS: 2116	Specification for sand for masonry mortars.
IS: 2386 (Parts-I to VIII)	Testing of aggregates for concrete.
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495 (Parts-I to IV)	Methods of tests of burnt clay building bricks.
IS: 3812	Specification for fly ash, for use as pozzolana and admixture.
IS: 4031	Methods of physical tests for hydraulic cement.
IS: 4032	Methods of chemical analysis of hydraulic cement.
IS: 4082	Recommendations on stacking and storage of construction materials at site.
IS: 8112	Specification for 43 grade ordinary portland cement.
IS:8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for Fly ash lime bricks.

Cast-In-Situ Concrete and Allied Works

IS: 280	Specification for mild steel wire for general engineering purposes.
IS: 456	Code of practice for plain and reinforced concrete.
IS: 457	Code of practice for general construction of plain & reinforced concrete for dams & other massive structures.
IS: 516	Method of test for strength of concrete.
IS: 650	Specification for standard sand for testing of cement.
IS:1199	Methods of sampling and analysis of concrete.
IS: 1791	General requirements for batch type concrete mixers.



IS: 1838 (Part-I)	Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS: 2438	Specification for roller pan mixer.
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 2505	General requirements for concrete vibrators, immersion type.
IS: 2506	General requirements for concrete vibrators, screed board type.
IS: 2514	Specification for concrete vibrating tables.
IS: 2645	Specification for Integral cement water proofing compounds.
IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
IS: 2750	Specification for Steel scaffolding.
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS: 3025	Methods of sampling and test waste water.
IS: 3366	Specification for Pan vibrators.
IS: 3370 (Part I to IV)	Code of practice for concrete structures for the storage of liquids.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3550	Methods of test for routine control for water used in industry.
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
IS: 4461	Code of practice for joints in surface hydro-electric power stations.
IS: 4656	Specification for form vibrators for concrete.
IS: 4925	Specification for batching and mixing plant.



IS: 4990	Specification for plywood for concrete shuttering work.
IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
IS: 5256	Code or practice for sealing joints in concrete lining on canals.
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
IS: 5624	Specification for foundation bolts.
IS: 6461	Glossary of terms relating to cement concrete.
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
IS: 9012	Recommended practice for shot concreting.
IS: 9103	Specification for admixtures for concrete.
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP: 23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/Sec.7) National Building Code- Structural design of prefabrication and



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systems building.

IS: 10297 Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.

IS: 10505 Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonry and Allied Works

IS: 1905 Code of Practice for Structural Safety of Buildings-Masonry walls.

IS: 2212 Code of Practice for Brickwork.

IS: 2250 Code of Practice for Preparation and use of Masonry Mortar.

SP: 20 Explanatory hand book on masonry code.

Sheeting Works

IS:277 Galvanised steel sheets (plain or corrugated).

IS: 459 Unreinforced corrugated and semi-corrugated asbestos cement sheets.

IS: 513 Cold-rolled carbon steel sheets.

IS: 730 Specification for fixing accessories for corrugated sheet roofing.

IS: 1626 Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.

IS: 2527 Code of practice for fixing rain water gutters and down pipe for roof drainage.

IS: 3007 Code of practice for laying of asbestos cement sheets.

IS: 5913 Methods of test for asbestos cement products.

IS: 7178 Technical supply conditions for tapping screw.

IS: 8183 Bonded mineral wool.

IS: 8869 Washers for corrugated sheet roofing.

IS: 12093 Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.

IS: 12866 Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).

IS: 14246 Specification for continuously pre-painted galvanised steel sheets and coils.



Fabrication and Erection of Structural Steel Work

IS: 2016	Specification for plain washers.
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
IS: 3502	Specifications for chequered plate.
IS: 6911	Specification for stainless steel plate, sheet and strip.
IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts.
IS: 6649	High Tensile friction grip washers.
IS: 800	Code of practice for use of structural steel in general building construction.
IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
IS: 9006	Recommended Practice for Welding of Clad Steel.
IS: 7215	Tolerances for fabrication steel structures.
IS: 12843	Tolerance for erection of structural steel.
IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube



IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.
IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.
IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.
IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars.

Part I Silicate type

Part II Resin type

Part III Sulphur type



IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumastic, Acid resisting grade.
Water Supply, Drainage and Sanitation	
IS : 458	Specification for concrete pipes.
IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
IS : 775	Cast iron brackets and supports for wash basins and sinks.
IS : 778	Copper alloy gate, globe and check valves for water works purposes.
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.
IS : 1172	Basic requirements for water supply, drainage and sanitation.
IS : 1230	Cast iron rain water pipes and fittings.
IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage.
IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes.
IS : 1726	Cast iron manhole covers and frames.
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.
IS : 1742	Code of practice for building drainage.
IS : 1795	Pillar taps for water supply purposes.
IS : 1879	Malleable cast iron pipe fittings.
IS : 2064	Code of practice for selection, installation and maintenance of



	sanitary appliances.
IS : 2065	Code of practice for water supply in building.
IS : 2326	Automatic flushing cisterns for urinals.
IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
IS : 2501	Copper tubes for general engineering purposes.
IS : 2548	Plastic seat and cover for water-closets.
IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
IS : 2963	Non-ferrous waste fittings for wash basins and sinks.
IS : 3114	Code of practice for laying of cast iron pipes.
IS : 3311	Waste plug and its accessories for sinks and wash basins.
IS : 3438	Silvered glass mirrors for general purposes.
IS : 3486	Cast iron spigot and socket drain pipes.
IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
IS : 4127	Code of practice for laying of glazed stone-ware pipes.
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS : 5822	Code of practice for laying of welded steel pipes for water supply.
IS : 5961	Cast iron grating for drainage purpose.
IS : 7740	Code of practice for road gullies.
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.



IS : 8934	Cast copper alloy fancy pillar taps for water services.
IS : 9762	Polyethylene floats for ball valves.
IS : 10446	Glossary of terms for water supply and sanitation.
IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.
Doors, Windows and Allied Works	
IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.
IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels
IS:2209	Mortice locks (vertical type).



IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.
Roof Water Proofing and Allied Works	
IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.
IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.
Floor Finishes and Allied Works	
IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.



IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white portland cement.
IS:13801	Specification for chequered cement concrete flooring tiles.
Painting and Allied Works	
IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship
Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint



IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use
IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.
Piling and Foundation	
IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation.
IS:2974 (Part-I TO V)	Code of practice for design and construction of machine foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.
IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
Part-I	Shallow foundations.
Part-II	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
DIN:4024	Flexible supporting structures for machines with rotating machines.
VDI:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing rotating imbalances in machines. Stop Log and Trash Rack
IS:4622	Recommendations for fixed - wheel gates structural design.
IS:5620	Recommendations for structural design criteria for low head slide gates.
IS:11388	Recommendations for design of trash rack for intakes.
IS:11855	General requirements for rubber seals for hydraulic gates. Roads
IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.



IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Publication	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
IS:73	Specification for paving bitumen
Loadings IS:875 (Pt. I to V)	Code of practice for design loads other than earthquake) for buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
M.O.T.	Deptt. of railways Bridge Rules.
Safety IS:3696 (Part I & II)	Safety code for scaffolds and ladders.
IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Safety code for demolition of buildings.



IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection on structural steelwork.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials
IS:11769	Guidelines for safe use of products containing asbestos.
-	Indian Explosives Act. 1940 as updated.
Architectural design of buildings	
SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)
Miscellaneous	
IS:802	Code of practice for use of structural steel in (Relevant parts) overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes. Publication

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measurement by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).



- b) Electronic transmitters BS:6447.
- 2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
- 3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controlling instrument - ANSI C 39.5 - 1974.
3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).
5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.
6. Printed circuit boards - IPC TM - 650, IEC 326 C.
7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).
11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).
12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.
13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.
14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.
15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.



16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.
17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.
18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.
19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.
20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.
21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232- D-1987.
22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.
2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).
2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).
3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.
2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.
3. Intrinsically safe apparatus - NFPA 493 1978.
4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.
5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTM A 296-82, Grade 7 P 316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.



3. Water and steam in power cycle - ASME PTC 19.11.
4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.
2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472
3. Damp heat cycling test - IS:2106
4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.
2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.
3. Turbine water damage prevention - ASME TDP-1-1980.
4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.
2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.
3. Surge withstand capability test - ANSI C 37.90 1 -1989.
4. Performance testing of UPS - IEC 146.
5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.
6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.
7. Printed Circuit Board - IPC TM 650, IEC 326C.
8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.
2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.
3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).



4. Codes for pressure piping - ANSI B 31.1
5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.
2. Seamless carbon steel pipe ASTM - A - 106.
3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.
4. Material for socket welded fittings - ASTM - A - 105.
5. Seamless ferritic alloy steel pipe - ASTM - A - 335.
6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.
7. Composition bronze of ounce metal castings - ASTM - B - 62.
8. Seamless Copper tube, bright annealed - ASTM - B - 168.
9. Seamless copper tube - ASTM - B - 75.
10. Dimension of fittings - ANSI - B - 16.11.
11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.
2. Material of socketweld fittings - ASTM - A105.
3. Dimensions of fittings - ANSI - B - 16.11.
4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.
2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.
3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorough 2/83.
4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).
5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.
6. Rules for Testing insulated cables and flexible cables : VVDE - 0472
7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)
8. Standard specification for tinned soft or annealed copper wire for electrical purpose



- ASTM B-33-81.
- 9. Oxygen index and temperature index test - ASTM D - 2863.
- 10. Smoke density measurement test - ASTM D - 2843.
- 11. Acid gas generation test - IEC - 754 - 1.
- 12. Swedish Chimney test - SEN - 4241475 (F3).
- 13. Teflon (FEP) insulation & sheath test - ASTM D - 2116.
- 14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.
- 15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

- 1. Guide for design and installation of cable systems in power generating station (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.
- 2. -do- Test Standards. NEMA VE-1-1979.
- 3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTM A - 386-78.

Public Address System

- 1. Specifications for loud speakers - IS:7741 (Part-I, II and III)
- 2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301
- 3. Specification for Public Address Amplifiers - IS:10426.
- 4. Code of practice for outdoor installation of PA system - IS:1982.
- 5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.
- 6. Basic environmental testing procedures for electronic and electrical items - IS:9000.
- 7. Characteristics and methods of measurements for sound system equipment - IS:9302
- 8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732
- 9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)
- 10. Fittings for rigid steel conduits for electrical wiring - IS:2667
- 11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.



Vibration Monitoring System

1. API 670 - 1994
2. BS : 4675 Part-2



MFGR.'s LOGO		MANUFACTURER'S NAME AND ADDRESS		MANUFACTURING QUALITY PLAN						PROJECT :								
				SUB-SYSTEM:				ITEM :		ACCEPTANCE NORMS		FORMAT OF RECORD		AGENCY		REMARKS		
SL. NO	COMPONENT & OPERATIONS	CHARACTERI STICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT											
					M	C / N												
1.	2.	3.	4.	5.	6.	7.	8.	9.	D *	** 10.						11.		
				LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.** M: MANUFACTURER/SUB-SUPPLIER C: SUPPLIER/NOMINATED INSPECTION AGENCY, N: THE OWNER P: PERFORM W: WITNESS AND V : VERIFICATION. AS APPROPRIATE, CHP: THE OWNER SHALL IDENTIFIED IN COLUMN "N"												DOC. NO.: REV CAT.....		
MANUFACTURER / SUB-SUPPLIER		MAIN- SUPPLIER		FOR THE OWNER USE														
SIGNATURE														REVIEWED BY	APPROVED BY	APPRO VAL SEAL		



ANNEXURE-II

SUPPLIER'S LOGO		SUPPLIER'S NAME AND ADDRESS		FIELD QUALITY PLAN						PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:			
				ITEM :		QP NO.: REV.NO.: DATE: PAGE: OF							
				SUB-SYSTEM :		CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT				
S. NO	ACTIVITY AND OPERATION	Characteristics / instruments	3.	4.	5.	6.	7.	8.	9.	D*	10.		
1.	2.												
		LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. LEGEND TO BE USED: CLASS #: A = CRITICAL, B = MAJOR, C = MINOR; 'A' SHALL BE WITNESSED BY THE OWNER FQA, 'B' SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)											
MANUFACTURER / SUB-SUPPLIER SIGNATURE		DOC. NO.: REV.....											
		FOR THE OWNER USE		REVIEWED BY		APPROVED BY		APPROVAL SEAL					



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PART OF SPECIFICATION PE-TS-426-501-A101

ANNEXURE-III

Project Package Supplier Bidder No.		Stage :				LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL				DOC. NO.:	
										REV. NO.:	
										DATE :	
										PAGE : OF	
		SUB-SYSTEM:									
S. N.	Item	QP / Insp. Cat.	QP No.	QP Sub. Schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks		
LEGENDS											
1. SYSTEM SUPPLIER / SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY THE OWNER)											
A – For these items proposed vendor is acceptable to the Owner. To be indicated with letter "A" in the list alongwith the condition of approval, if any.											
DR – For these items "Detailed required" for the Owner review. To be identified with letter "DR" in the list.											
NOTED – For these items vendors are approved by Main Supplier and accepted by the Owner without specific vendor approval from the Owner. To be identified with "NOTED."											
2. QP / INSPN CATEGORY:											
CAT-I: For these items the Quality Plans are approved by the Owner and the final acceptance will be on physical inspection witness by the Owner.											
CAT-II: For these items the Quality Plans approved by the Owner. However no physical inspection shall be done by the Owner. The final acceptance by the Owner shall be on the basis review of documents as per approved QP.											
CAT-III: For these items Main Supplier approves the Quality Plans. The final acceptance by the Owner shall be on the basis certificate of conformance by the main supplier.											
UNITS / WORKS: Place of manufacturing Place of Main Supplier of multi units/works.											



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[illegible]

ANNEXURE-V

Project : Stage :		FIELD WELDING SCHEDULE (To be raised by the Bidder)				DOC. NO.:									
Bidder No. :		Welding Code:				REV. NO.:									
System :						DATE :									
						PAGE : OF									
Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions	Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/Quantum	REF		Remarks
										Temp.	Holding time		Spec No.	ACC Norm Ref.	
NOTES:															
SIGNATURE															



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ANNEXURE-VI
DOCUMENTS DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	6*	1	-	-	2	1	-	-
2.	Final Approved Documents	2	1 + 1 CD	1	1	1	1 + 2 CD	4	1 + 1 CD
3.	Drawings / Documents 'As Built'	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
4.	Type Test Reports (Initial)	4*	1 + 1 CD	-	-	2	1 + 2 CD	-	-
5.	Type Test Report (Final)	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1 + 1 CD	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2	1 + 1 CD	-	-	2	1 + 2 CD	2	1 + 1 CD
8.	Erection Manual (Draft)	3*	1CD	-	-	1	1CD	-	-



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S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
9.	Erection Manual 'Final'	1	1CD	1	-	1	1CD	2	1CD
10.	O&M Manual 'Draft'	3*	1CD	+	-	1	1CD	-	-
11.	O&M Manual 'Final'	1	1CD	1	-	1	1CD	2	2CD
12.	Commissioning Procedure 'Draft'	3*	1CD	-	-	1	1CD	-	-
13.	Commissioning Procedure 'Final'	1	1CC	1	-	1	1CD	2	1CD
14.	PG Test Procedure "Draft"	3*	1	-	-	1	1	-	-
15.	PG Test Procedure 'Final'	1	1 + 1 CD	1	-	2	1 + 1 CD	2	1 + 1CD
16.	Progress Report	3	1CD	1	-	2	1CD	1	1CD
17.	PG Test Report for Approval	4*	1	-	-	2	1 + 1 CD	-	-
18.	Approved PG Test Report	1	1 + 1 CD	1	-	2	1 + 1 CD	4	1 CD
19.	Project Completion Report	1	1 + 1 CD	1	-	1	1CD	1	1CD
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1CD	-	-	1	1CD	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	6*	1	-	-	2	1CD	-	-
23.	Manufacturing QPs, Field QP, Final	1	1CD	1	-	2	1CD	2	1CD
24.	QA documents Package for equipment / field activities etc.	1	1CD	1	-	1	1CD	1	1CD



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* -

HC -

CC -

CD -

HO -

Consultant will return one (1) commented document to Vendor and CE (UPRVUNL), Lucknow

Hard Copy

Soft Copy thru e-mail

CD ROM

Head Office of Consultant / UPRVUNL



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
STEAM GENERATOR	Thermal design and hydraulic circulation balance	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipments	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collection analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. Calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation		R&D work in-progress	
	Duct design.			
	Pressure part			
	Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners start-up system, fuel firing system, draft plant			
	Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.			



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
	Layout of overall plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc. Erection strategies, erection procedures Performance and demonstration tests.			
MANDAYS	120	20	20	20
CFD model development and validation for Steam Generator	Familiarisation of fundamentals and basis for the development of the CFD models.			
	Solving of set of simple problems by Owner's engineers with the help of trainer.			
	Hands on experience on the development of detailed/realistic CFD models for the steam generator and ESP. The Bidder/trainer shall develop CFD models for SG & ESPs per the Contract requirement with complete association of the Owner's engineers.			
	Validation of the above CFD model for SG & ESP by Bidder in association with the Owner's Engineers.			
MANDAYS	120 for SG and 60 for ESP	-	-	-



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PART OF SPECIFICATION PE-TS-426-501-A101

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Visit To Manufacturer's Work Of Plant
	Product Design	Plant Visit	Manufacturing processes of turbine	
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIE S	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Assembly of turbine	
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Testing of turbines	
	Rotor dynamic behaviour studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Product development in process	
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Future plan for technology induction	
	Casing & diaphragm design	Failure analysis	R&D work in progress	
	Labyrinth seal selection & design for different turbine configurations			
	Selection of turbine type (i.e. Tandem vs. cross compounding, separate HP/IP vs. combined HP/IP, material of construction etc.)			
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation			
	Selection, design and control principle for Turbine governing system			



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
MANDAYS	Performance calculation			
	Steam path audit			
	Layout principle of various equipment's of TG and its integral system			
	Latest technological advancements			
	45	10	10	
Boiler Feed Pumps	Techno-economic studies for Selection of BFP Configuration and its drive	Familiarization of power plants of various makes of feed pumps	Manufacturing process of various components of BFP	
	Criteria for selection of boiler Feed Pump parameters	Data collection of BFP parameters and configuration	Assembly of BFP	
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	
	Role of critical parameters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP & its features	Future plan for technology induction	
	Material selection of BFP components			
	Guiding factors for selection of BFP seals		R&D work in progress	



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT				Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work		
CONDENSER	Computation of axial thrust under various flows				
	Performance calculation				
	Transient analysis in pump suction piping wrt NPSH margin				
	Latest technological trends in BFP design				
	20	5	10		
MANDAYS	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly		
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality	Collection of data for analysis of availability of Condenser	Testing capability at works		
	Condenser support selection & design	O&M history/problems related to condenser	Product development in process		
	Sizing of condenser w.r.t. super critical units		Future plan for technology induction		
	Latest technological trends in condenser arrangement and design		R&D work in progress		
MANDAYS	Condenser vacuum system design				
	10	5	5		
Feed Regenerative Equipment'	Thermal and mechanical design calculation of heaters	Comparative studies of salient features	Manufacturing process of various components of heaters		
	Basis of selecting horizontal/vertical	Analysis of data	Assembly		



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
s	heaters			
	Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate	O&M history/problems related to heaters	Testing capability at works	
	Configuration of HP heaters (2x50% v/s100% capacity		Product development in process	
	Sizing criteria for De- aerator/Heaters		Future plan for technology induction	
	Selection of tube & tube sheet material of heaters		R&D work in progress	
MANDAYS	Latest technological trends in heaters design			
	15	10	10	
3-dimen- sional CFD modelling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	20			
Training for Balance of Plant Equipment	120	40	40	40
	The details of training modules for various BoP equipments & systems shall be decided during detailed engineering.			



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CONTROL & INSTRUMENTATION			
DDCMIS-Man Machine Interface - Hardware & Operating System	Hardware & Software organization of the system Basis of selection of H/W memory sizing Operating system features, interface with other system, openness & inter- operability Upgradability System testing features	Operational feedback	
MANDAYS	16	6	
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development Development of mimics Other application like calculations, logs historical storage functionalities & use	Operation feedback	
MANDAYS	40	6	
DDCMIS - Control System Hardware	Basic design features for system & its modules System capabilities & system design techniques Communication with MMI & other system	Operation feedback Manufacturing processes special attention to handling of the modules Maintenance facilities	
MANDAYS	20	5	10



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AREAS OF TRAINING REQUIREMENT



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
Turbine protection system & ATRS	Implementation of failsafe philosophy in turbine protection system			
MANDAYS	10	3	3	
Furnace and Flame Viewing System.	Theory & principle of operation Details of software & methods of modification/ customisation	Operational feedback		
Misc. systems for SG/TG C&I				
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope.				
QUALITY ASSURANCE & INSPECTION QA SYSTEM & PROGRAMME	Integrated QA Management System for enhanced reliability of equipments	Operational feedback Co-relation of reliability and performance of the equipment with implementation of QA system.	Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities.	
	QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems			
	QA system for developing and establishing new processes and vendors.	Appreciation of use of	Appreciation of developmental	



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PRODUCT	AREAS OF TRAINING REQUIREMENT				Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work		
		structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant	activities for new processes and vendors. System of prequalification of special processes		
	System of structured documentation of Engg. And test records				
MANDAYS	16	3			
PLC	Hardware organization		Manufacturing process of PLC hardware		
	Operating system features		Integration & testing facilities		
	Data base organization				
	Logic/loop algorithm				
	Development of control logic & loop s/w & MMI application development				
MANDAYS	16	-	2		
Electric Power Supply System (UPS & 24 V DC system)	Theory & design features		Manufacturing/assembly process Testing methodology		
MANDAYS	10	2			
PRODUCT (ELECTRICAL) GENERATOR	AREAS OF TRAINING REQUIREMENT				
	(a) Design aspects of the following areas	- Operational feed back	(a) Manufacturing process for		



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT				Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work		
MANDAYS	- Insulation system	- Familiarisation with different sub- systems	- Core		
	- Cooling medium & arrangement		- Winding bars		
	- Winding & core support systems		- Assembly		
	b) Design aspects of other auxiliary systems	15	(b) Testing facilities		
	30		15		
	Generator Excitation System including AVR.	Design features of various sub- systems Excitor PMG Transformer Controllers & different limiters etc. PSS & associated system studies	- Operational feed back - Familiarisation with various equipment functioning at reference plants	- Manufacturing process& testing facilities for various equipment of excitation system	
400 KV Switchyard Equipments			Concepts and operational aspects for the offered equipments	Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at UPRVUNL site	
Substation Automation System					
MV AND LT Switchgear: Numerical relays & Switchgear SCADA system	Numerical relay engineering & associated training for relay software & O&M SCADA system design, engineering & associated training for SCADA & O&M				



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			Operation & Maintenance Of Plant
	Product Design	Plant Visit	Visit To Manufacturer's Work	
MDBFP motor CW motor & BWCP motor	Design criteria for the stator core and winding, rotor core & winding, Insulation system & Cooling arrangement Study of forces & vibration Diagnostic & testing of large Electrical machines	Operational feedback	Manufacturing process & testing facilities	
	MANDAYS 30	15	15	
	Boiler Feed pump H.T. Motor	Design Criteria for the Stator core & wdg Rotor core & wdg Insulation system Cooling arrangement	Operational feed back	Manufacturing process & test facilities
MANDAYS CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers Design and stress analysis of lines with Expansion Joints together with Owner's engineers	5	5	
		Familiarization with feedback (in super critical plant) on failure analysis and vibration analysis of piping. Study of Feed back regarding hanger setting strategies and practice	Cold Setting of spring hanger Cyclic tests carried on spring hangers.	
			Cyclic tests carried on expansion joints	



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ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance Of Plant
MANDAYS	Design and stress analysis of piping systems with two phase flow involving Owner's engineers		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
	Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.			
	Static and dynamic analysis of critical piping including seismic and other occasional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers.			
	Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system.			
	Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
	45	10	10	



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ANNEXURE-VII		
Area	Topics	Mandays
DDCMIS-Man Machine Interface-Hardware & Operating System	Hardware & Software organization of the system	20
	Basis of selection of H/W memory sizing	
	Operating system features, interface with other system, openness & inter-operability	
	Upgradeability	
	System testing Features	
	Trouble shooting & fault analysis	
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization	40
	Various system modules & interface with OS	
	Database organisation & development	
	Development of mimics	
	Other application like calculation, logs historical storage functionalities & use	
	Trouble shooting & fault analysis	
DDCMIS-Control System Hardware & Control System Application Software	Basic design features for system & its modules	50
	Manufacturing process with special attention to handling of the modules Maintenance facilities	
	System capabilities & system design techniques	
	System integration & system capabilities testing	
	Communication with MMI & other system	
	Database structure Organisation & inter-face between application program & database	
	Application for implementation of Control functions	
DDCMIS- Operator Training	Study of standard algorithms & development of new algorithms	20+100
	Trouble shooting & fault analysis	
	Use of the system at Works + at Site	
DDCMIS- Specialized Network security training	To be finalized during detailed engineering.	15

UPS system	Theory & design features Manufacturing/assembly process Testing methodology	5
24 V DC system	Trouble shooting and fault analysis. Theory & design features Manufacturing/assembly process Testing methodology	5
SWAS	Trouble shooting and fault analysis Theory & design features Trouble shooting and fault analysis	5
Communication System	Theory & design features Trouble shooting and fault analysis	4
PSSS System	Theory & design features Trouble shooting and fault analysis	5
QA SYSTEM & PROGRAMME	Integrated QA Management system for enhanced reliability of equipments QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems QA system for developing and establishing new processes and vendors System of structured documentation of Engg and test records Appreciation of implementation of QA Programme in various manufacturing, assembly and testing activities Appreciation of develop-mental activities for new processes and vendors System of pre-qualification of special processes	10
Controls & Instruments	Familiarization with control system and instrumentation QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items Implementation of testing programme to ensure reliability	20
Simulator	a. System design structure and basis of design b. Hardware components and their configuration c. System Software and Simulation Software Tools d. Plant process modelling and DCS emulation e. Project specific application development, configuration and modifications including equipment modelling and interconnections of models, graphics development , configuring equations etc, f. Maintenance and troubleshooting of hardware and software components	24



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PADO	Theory & design features	10
	Trouble shooting and fault analysis	
CEMS	Theory & design features	5
	Trouble shooting and fault analysis	
AAQMS	Theory & design features	5
	Trouble shooting and fault analysis	
C&I Lab Instruments	Theory & design features	6
	Trouble shooting and fault analysis	
DMS	Theory & design features	5
	Trouble shooting and fault analysis	
Station LAN & MIS	Theory & design features	5
	Trouble shooting and fault analysis	
Note	One week shall constitute of five (5) man days.	



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CHAPTER 6 : ERECTION CONDITIONS OF CONTRACT

1.0 GENERAL

1.1 The following provisions shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Owner and the Contractor prior to commencement of erection work.

1.2 The Contractor upon signing of the Contract shall, in addition to a Project Co-ordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.

2.0 REGULATION OF LOCAL AUTHORITIES AND STATUTES

2.1 In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract. Some labour welfare schemes & rules to be followed by Contractor are annexed to this section as Annexure I & Annexure II. However, these are minimum & should be limiting criteria.

2.2 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Owner, shall be to the account of the Owner. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.

3.0 WELDING OF PRESSURE PARTS AND HIGH PRESSURE PIPING

The welding of all pressure parts and high pressure piping shall be in accordance with the following requirements:

3.1 Qualification of Weld Procedures

Only qualified welding procedures as per ASME Section IX shall be used by contractor at site. Procedure, qualification records along with WPS shall be submitted for review. Welding procedure shall indicate all essential and non essential parameters as per ASME Section IX. Makes of welding consumables shall be subject to Owner's approval.

3.2 Welder's Qualification

3.2.1 Welders, who are qualified in accordance with the latest applicable requirements of the Indian Boiler Regulations, shall be permitted to perform any welding work on the pressure parts and its attachment welding. In addition



to such statutory qualification requirements, the welders shall also undergo a satisfactory pre-production qualification test to be conducted by the Contractor at site as per ASME Section IX in presence of Owner / Engineer, prior to performing work under these specifications. The services of an independent testing laboratory shall be retained by the Contractor to perform welder qualification tests for welders.

- 3.2.2 All the welders carrying out welding at site shall carry an identification badge, which shall indicate the category and the grade of welding for which they have been tested and authorized to carry out welding. All such badges shall be countersigned by the Owner.

3.3 Records

Welders' performance shall be monitored regularly and record of their performance shall be maintained by contractor in a manner acceptable to the Owner. Contractor shall maintain such records including record of procedure qualification & welder qualification and hand-over to the Owner at the end of work.

3.4 Marking

On completion of each joint, the welder shall mark his regularly assigned identification mark near the joint. The welder's identification numbers, inspection stamps or code symbol stamps and any other information shall not be directly stamped on any alloy steel piping. In alloy steel piping, all such information shall be stamped on separate marking plate which shall be tack welded on pipe near the weld.

4.0 HEAT TREATMENT

- 4.1 Pre-heating, post-heating and post-weld stress relief operations of all welds, shall be performed in accordance with the requirements of applicable code. Local post weld stress relieving heat – treatments shall be adopted only in cases where it is normally impracticable to subject the entire assembly as such for stress relieving operations. Heating may be by means of electric induction coils or electric resistance coils. Oxy-acetylene flame heating or exothermic chemical heating methods will not be permitted. Complete recording of the temperatures throughout the stress relieving cycle of the material and the weld subjected to heat treatment shall be made by means of a potentiometric recorder. Recorders other than those of potentiometric type shall not be used for such temperature recording during stress relieving operations.

- 4.2 The contractor & Owner's representative, at start and at the end of HT Cycle shall sign the time and temperature charts for heat-treatment.

- 4.3 After setting up the weld joint for heat treatment operation, the Owner's signature shall be obtained on the strips chart of the recorder prior to starting of heat treatment cycle. The right hand corner of the strip chart at the starting point of the heat treatment cycle shall contain details like the weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding Schedule (as specified at clause # 7.0 of this chapter) etc.



5.0 Weld Edge Preparation

Preparation at site of weld joint shall be in accordance with details acceptable to the Owner. Wherever possible, machining or automatic flame cutting shall be used for edge preparation. Hand flame cutting will be permitted only where edge preparation otherwise is impractical. All slag shall be removed from cuts and all the hand cuts shall be ground smooth to the satisfaction of the Owner. Flame cutting of alloy steel pipe shall be avoided. Wherever such cutting is done, a 200mm length at the cut face shall be removed by machining. Pneumatic hand tools such as edge preparation, tube cutting machine can be used.

6.0 CLEANING AND SERVICING

6.1 The inside of all tubes, pipes, valves and fittings shall be free from dirt and loose scales before being erected. All the pipelines shall be thoroughly blown and/or flushed. Each steam and water tubes shall be blown with compressed air and shall be subjected to 'ball test' before erection to ensure that no obstructions exist. A system for recording of all such operations shall be developed and maintained in a manner to ensure that no obstructions are left inside the tubes and no tubes are left uncleaned and untested.

6.2 All valves and valve actuators, and dampers and damper actuators, if any, shall be thoroughly cleaned and serviced prior to pre-commissioning tests and/or Initial Operations of the plant. A system for recording of such servicing operation shall be developed and maintained in a manner acceptable to the Owner and to ensure that no valves or dampers including their actuators are left unserviced.

6.3 All interior surfaces of the turbine shall be thoroughly cleaned prior to boxing-up to remove all traces of oil preservations.

7.0 FIELD WELDING SCHEDULE

The Contractor shall submit to the Owner, a certified and complete field welding schedule for all the field welding activities to be carried out in respect of the pressure parts involved in the equipment furnished and erected by him, at least 90 days prior to the scheduled start of erection work at site. Such schedule will be strictly followed by the Contractor during the process of erection. The above field-welding schedule to be issued by the Contractor shall contain the following:

- (a) Drawing No. (s)
- (b) Location of the weld
- (c) Size of the weld (outside diameter and thickness)
- (d) Type of joints
- (e) Material specifications
- (f) Size of fillet on backing ring, when the type of joint is with backing ring
- (g) Electrode / filler metal specifications
- (h) Number of welds per unit
- (i) Quantity of filler metal per weld
- (j) Indication of required Non-destructive Examination (NDE) for each weld
- (k) Pre-heat temperatures for welding
- (l) Process of welding
- (m) Post-welding heat treatment temperature ranges, duration, under as specified at clause no. 4.0 – of this chapter entitled "Heat Treatment".



- (n) Qualification details of weld procedures to be adopted as specified under as specified at clause no. 3.1 – of this chapter entitled "Qualification of Weld Procedures".

8.0 SITE RUN MISCELLANEOUS PIPING

Sketches or diagrams of the proposed routings of all piping not already indicated and routed on the shop drawings which were reviewed by the Owner, shall be submitted to the Owner for review. Owner's acceptance of such site routings shall be obtained before the piping is erected. All these site run piping shall be installed in such a manner as to present an orderly and neat installation. They shall be located as to avoid obstruction of access and passages. Valves, instruments or any other special items shall be located convenient for operation by the operating personnel. Pipe runs shall be plumb or level except where pitch for drainage is required. Pipe runs that are not parallel to the building structure, walls or column rows shall be avoided so that deflection of pipes between hangers does not exceed 6mm. No miscellaneous pipe shall be routed and installed above or adjacent to electrical equipment.

9.0 THERMAL EXPANSIONS

All piping installation shall be such that no excessive or destructive expansion forces exist either in the cold condition or under condition of maximum temperature. All bends, expansion joints and any other special fittings, necessary to provide proper expansion, shall be incorporated. During installation of expansion joints and anchors, care must be taken to make sure that full design movement is available at all times for maximum to minimum temperature and vice-versa.

10.0 PIPING SUPPORTS

- 10.1 Hangers, supports and anchors shall be installed as required to obtain a safe, reliable and complete pipe installation. All supports shall be properly levelled and anchored when installed. The anchors shall be so placed that thermal expansion will be absorbed by bends without subjecting the valves or equipment to excessive strains.

- 10.2 The hanger assemblies shall not be used for the attachment of rigging to hoist the pipe into place. Other means shall be used to securely hold the pipe in place till the pipe support is completely assembled and attached to the pipe and building structures and spring support is set to accommodate the pipe way. All temporary rigging shall be removed in such a way that the pipe support is not subjected to any sudden load. All piping, having variable spring type supports, shall be held securely in place by temporary means during the hydraulic test of pipe system. Constant support type spring hangers used during hydraulic test shall be pinned or blocked solid during the test. After complete installation and insulation of the piping and filling of the piping with its normal operating medium, the pipe support springs shall be adjusted to the cold positions. If necessary, the spring support shall be re-adjusted to the hot positions after the line has been placed for service at its normal maximum operating temperature conditions. Electric arc welding only shall be used to weld all pipe supports to structural steel members that form part of the building supporting structure. The structural beams shall not be heated more than necessary during welding of supports and such welds shall run parallel to the axis of the span. All lugs or any other attachments welded to the piping shall be of the same material as the pipe.



11.0 PRESSURE TESTING

11.1 On completion of erection of pressure parts, a hydraulic test in accordance with the requirements of the Indian Boiler Regulations shall be performed by the Contractor.

11.2 All the valves, high pressure pipes and inter-connected pipes connecting the pressure parts shall be tested along with pressure parts. All blank flanges or any removable plugs required for openings not closed by the valves, and piping provided, shall be furnished by the Contractor. The pressurization equipment including water piping from the supply, needed for the above test shall also be furnished by the Contractor. Any defects noticed during the testing are to be rectified and the unit re-tested. If any welding is done on the pressure parts after the Hydraulic test, the Hydraulic test for that portion of pressure parts shall be repeated.

11.3 The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting Authority as per the provisions of the Indian Boiler Regulations and the Owner.

12.0 THERMOWELLS AND FLOW NOZZLES

12.1 All the thermo wells and flow nozzles in the equipment furnished under the technical specifications shall be installed as a part of this work.

12.2 All thermo well connections incorporated in the steam service shall be plugged during the pressure testing and the blow out of steam piping systems. Upon completion of the blow out operation, all thermo wells shall be installed and seam welded. Similarly, all flow nozzles in the steam lines shall also be installed only on completion of steam blowing operations unless otherwise agreed to by the Owner, depending upon the sequence of cleaning and purging operations to be adopted by the Contractor at the field.

13.0 INSULATION, LAGGING AND CLADDING

The provision of insulation, lagging and cladding of the various equipments and portion of the equipment covered under the Contract, shall be furnished by the Contractor as specified elsewhere or agree to separately in writing. Welds required for holding insulation on pressure parts shall be carried out by IBR qualified welder.

13.1 In case of equipment other than steam turbine, Lugs made out of MS rods of 5mm dia conforming to IS 280 or equivalent shall be welded on the surface at intervals of 250mm pitch zigzag to support insulation. Mineral wool mats with wire netting on both sides shall be applied against the surface with lugs piercing through. The edges of mattress shall be laced together with galvanized MS 0.71mm dia (22 SWG) IS 280 or equivalent (soft) lacing wire. Galvanized binding wire of 1.63 mm dia (16 SWG) IS 280 or equivalent (soft) will be used criss-cross between lugs to hold it. The lugs will then be bent over the netting.

13.2 Unless otherwise specified, all equipment insulation shall be covered with aluminium cladding / jacketing. The thickness of aluminium sheet shall not be less than 0.63mm. Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminium cladding with copper, copper alloys, tin, lead nickel or nickel alloys including monel metal. Where cladding is attached to



carbon steel or low alloy steels, the steel shall first be prime painted with zinc chromate and then painted with aluminium paint. The use of lead base paints for this purpose shall be avoided.

- 13.3 Prior to application of cladding, all surface imperfections such as ducts, cracks and voids shall be filled with insulation cement so as to form a smooth base for the final shall be machine rolled and formed. All overlaps at longitudinal joints shall face downwards. The fixing of cladding shall be by means of screws and they shall be adequate in number and be so place is such location as to produce tight joints eliminating 'bellying'. The screws, as far as possible, shall be uniformly placed and on centres not exceeding 150mm except where insulated outside diameters are smaller than 230mm in which case spacing shall be on centres not exceeding 100mm. Self tapping type screws, of 12mm size of stainless steel / aluminium alloy as per the requirements shall be used. All joints wherever possible shall be lapped a minimum of 50mm. The overlaps of longitudinal joints shall be a 10mm turn back edge. Butt joints such as those at piping tees, shall be made using a rolled seam. Suitable provisions for expansion movement shall be provided in joints. Hinged or sliding doors for convenience shall be provided in the cladding at all access openings, non-projecting connections, important codes stampings etc.

13.4 Piping, Pipe Fittings & Valves

All piping insulation and metal cladding furnished with the equipment to be erected shall be applied as specified herein.

13.4.1 Piping

The insulation on piping shall be applied using wire loops on 150mm centres. These wire loops shall be thoroughly embedded into the outer insulation surface and all cracks, voids and depressions shall be filled with insulating cement suitable for the piping temperature so as to form a smooth base for application of cladding. The wires used for piping insulation shall be of 20 SWG. The surface shall be smooth and uniform before applying the outer covering. All piping insulation ends shall be terminated at a sufficient distance from flanges to facilitate removal of bolts.

13.4.2 Flanges

Insulation on flanges shall be by means of blocks of insulating material securely bound to the flange by wire loops. Such blocks of insulation shall be long enough to overlap the adjacent pipe insulation by an amount equal to the thickness of adjacent pipe insulation. Smooth finish shall be obtained by the application of insulating cement. Alternatively, sectional pipe insulation of proper diameter may be used. Insulation on flanges shall not be done until the pipe and equipment have been in service during the initial operation and till all the flange bolts have been re-tightened.

13.4.3 Bends and Elbows

Insulation on bends and elbows shall be cut into sections sufficiently short to form a reasonable smooth external surface. After the application of insulation material in place, it shall be smoothly coated with insulating cement. Elbows may be insulated as above or alternatively by means of specially moulded insulation enclosures.



13.4.4 Cladding

Cladding shall be of aluminium sheet of thickness as per details given in detail Technical Specification or will be provided during detail engineering shall be machine rolled and formed to accurately fit insulation curvatures. Cladding shall be secured using self-tapping screws. Screws shall be adequate number and so located as to produce tight joints. The spacing of screws shall be as far as possible uniform and on centres not exceeding 150mm. For outside diameters less than 230 mm, spacing of screws shall be on centres not exceeding 100mm adequate number of screws shall be provided for fixing the cladding and be so placed in such locations, as to produce a smooth cladding finish without 'bellying'. Insulated elbows having insulated diameters less than 330mm shall be provided with preformed smooth aluminium elbow jackets. Wherever possible, all joints should be lapped a minimum of 50mm with joints facing downwards and so placed that they are obscured from normal points of vision. All the joints in the cladding shall be made with suitable provisions for expansions. All butt joints such as those at piping tees shall be made using rolled seams. In addition, to prevent galvanic corrosion, suitable action, as stipulated as specified at clause no 13.5 of this chapter, shall be taken.

13.4.5 Valves and Fittings

All valves and fittings installed in the pipelines shall also be applied with insulation and furnished with suitably shaped boxes so as to facilitate easy dismantling of the fittings. The insulation thickness for valves, valve fittings etc. shall be same as that used on the line on which they are installed. All voids shall be properly filled up with insulating material and as per the directions of the Owner.

13.5 Protection of Equipment during Insulation Applications

All equipment and structures shall be suitably protected from damage while applying insulating after completion of insulation. All equipment and structures shall be thoroughly cleaned and remove insulating materials which might have fallen on them.

14.0 Code Requirements

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian Electricity Rules & Codes, Indian Boiler Regulations, CEA Guidelines, ASME codes and accepted good practices, the Owner's Drawings and other applicable Indian recognized codes and laws and regulations of the Government of India.

15.0 Electrical Safety Regulations

15.1 In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the other Contractor or Owner.

15.2 Before the Contractor connects any electrical appliances to any plug or socket belonging to the other Contractor or Owner, he shall:

- (a) Satisfy the Owner that the appliance is in good working condition;
- (b) Inform the Owner of the maximum current rating, voltage and phases of the appliances;



- (c) Obtain permission of the Owner detailing the socket to which the appliances may be connected.

The Owner will not grant permission to connect until he is satisfied that

- (a) The appliance is in good condition and is fitted with a suitable plug.
- (b) The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthed metal sheath surrounding the cores.

15.3 No electric cable in use by the other Contractor / Owner will be disturbed without permission. No weight of any description will be imposed on any such cable and ladder or similar equipment will rest against or be attached to it.

15.4 No repair work shall be carried out on any live equipment. The equipment must be declared safe by the Owner and a permit to work issued before any work is carried out.

15.5 The Contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation.

16.0 Removal of Material

No material bought to the site shall be removed from the site by the contractor and/or his sub-contractors without the prior written approval of the OWNER.

17.0 INSPECTION, TESTING AND INSPECTION CERTIFICATES

The provisions of the clause entitled Inspection, Testing and Inspection Certificates given in Chapter 05: GTR, Volume-II, shall also be applicable to the erection portion of the Works. The Owner shall have the right to re-inspect any equipment through previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Owner rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification / repairs as may be necessary to the satisfaction of the Owner. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.

18.0 ACCESS TO SITE AND WORKS ON SITE

18.1 Suitable access to site and permission to work at the Site shall be accorded to the Contractor by the OWNER in reasonable time.

18.2 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the OWNER or his representative.

19.0 CONTRACTOR'S SITE OFFICE ESTABLISHMENT

The Contractor shall establish an Office at the Site and keep posted an authorized representative for the purpose of the Contract. Any written order or



instruction of the Owner or his duly authorized representative shall be communicated to the said authorized resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

20.0 CO-OPERATION WITH OTHER CONTRACTORS

20.1 The Contractor shall co-operate with all other Contractors or Workmen of the Owner, who may be performing other works on behalf of the Owner and the workmen who may be employed by the Owner and doing work in the vicinity of the works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the OWNER, due to the Contractor's work shall promptly be made good at his own expense. The OWNER shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the OWNER in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the OWNER on that account other than an extension of time for completing his works. OWNER shall have full access to visit the contractor's site at any time for inspection and surveillance checks.

20.2 The OWNER shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The OWNER shall determine the corrective measures if any, required to rectify this situation after inspection of the works and such decisions by the OWNER shall be binding on the Contractor.

21.0 DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the UPRVUNL in respect of his employees and workmen at Site. The UPRVUNL shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site, if in the opinion of the UPRVUNL such employee has mis-conducted himself or is incompetent, negligent or otherwise undesirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

22.0 CONTRACTOR'S FIELD OPERATION

22.1 The Contractor shall keep the OWNER informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the OWNER shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the OWNER or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

22.2 The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and all the properties under his custody during the performance of



the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the OWNER is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.

23.0 PHOTOGRAPHS AND PROGRESS REPORT

23.1 The Contractor shall furnish three (3) prints each to the OWNER of progress photographs of the work done at Site. Photographs shall be taken as and when indicated by the OWNER or his representative. Photographs shall be adequate in size and number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the photograph.

23.2 The above photographs shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.

23.3 The Contractor shall submit the progress of work in video cassettes (2 copies) quarterly highlighting the progress and constraints at site.

24.0 MAN-POWER REPORT

24.1 The Contractor shall submit to the UPRVUNL, on the first day of every month, a man hour schedule for the month, detailing the man hours scheduled for the month, skill- wise and area-wise.

24.2 The Contractor shall also submit to the UPRVUNL on the first day of every month, a man power report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill- wise and the areas of employment of such labour.

25.0 PROTECTION OF WORK

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the UPRVUNL. No claim will be entertained by the UPRVUNL or the representative of the UPRVUNL for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions of the as specified at clause no 20.00.00- of this chapter entitled "Co-operation with other Contractors." The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

26.0 EMPLOYMENT OF LABOUR



- 26.1 In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.
- 26.2 All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.
- 26.3 The hours of work on the Site shall be decided by the UPRVUNL and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day - Monday through Saturday.
- 26.4 Contractor's employees shall wear identification badges while on work at Site.
- 26.5 In case the OWNER becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contract Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the OWNER may make such payments and shall recover the same from the Contractor's Bills.
- 27.0 FACILITIES TO BE PROVIDED BY THE UPRVUNL
- 27.1 Electricity
Complete construction power requirement (including power for bidder's labour camp & staff colony) will be available on chargeable basis based on prevailing commercial rates of DISCOM.
- 27.2 Water
Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony.
- 27.3 Communication
The OWNER will extend the telephone facilities, if available at Site, for purposes of Contract. The Contractor shall be charged at actual for such facilities.
- 27.4 Railway Siding
Railway siding shall be provided by OWNER for coal transportation to site. However the same may not be available to the bidder for material/supplies transport etc. Bidder has to plan on its own for movement of ODC consignment to plant site.
- 27.5 Handing over of Site for construction

Further, irrespective of readiness of railway siding, owner reserves the option of coal supply in stockyard before the synchronization of unit for which bidder has to ensure readiness of coal supply system up to mill bunker.
- 28.0 FACILITIES TO BE PROVIDED BY THE CONTRACTOR
- 28.1 Contractor's site office Establishment



The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC.

28.2 Tools, tackles and scaffoldings

The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipments covered under the Contract. He shall submit a list of all such materials to the UPRVUNL before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the UPRVUNL. The Contractor shall arrange Dozer, Hydra, Cranes, Trailer, etc. for the purpose of fabrication, erection and commissioning.

28.3 Testing Equipment and Facilities

The contractor shall provide the necessary testing, equipment and facilities.

28.4 Site laboratory for civil works

Contractor shall provide and maintain a site laboratory for the testing of construction material under the direction and general supervision of UPRVUNL.

28.5 First-aid

28.5.1 The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.

28.5.2 The UPRVUNL will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.

28.6 Cleanliness

28.6.1 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the UPRVUNL. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.

28.6.2 Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the UPRVUNL. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor

29.0 LINES AND GRADES

29.1 All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works..



- 29.2 Basic horizontal and vertical control points will be established and marked by the Owner at Site at suitable points. These points shall be used as datum for the works under the Contract. The Contractor shall inform the Owner well in advance of the times and places at which he wishes to do work in the area allotted to him so that suitable datum points may be established and checked by the Owner to enable the Contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Owner at Contractor's expense.
- 30.0 FIRE PROTECTION
- 30.1 The work procedures that are to be used during the erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.
- 30.2 Similarly corrugated paper fabricated cartons etc. will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.
- 30.3 All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.
- 30.4 The Contractor shall provide enough fire protection equipment of the types and number for the warehouses, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all time.
- 31.0 SECURITY
- The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the UPRVUNL Site only with the written permission of the UPRVUNL in the prescribed manner.
- 32.0 CONTRACTOR'S AREA LIMITS
- The Owner will mark-out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move out of the areas marked out for his operations. In case of such a need for the Contractor's personnel to



work out of the areas marked out for him the same shall be done only with the written permission of the Owner.

33.0 CONTRACTOR'S CO-OPERATION WITH THE OWNER

In case where the performance of the erection work by the Contractor affects the operation of the system facilities of the UPRVUNL, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the UPRVUNL and the same shall be acceptable at all times to the Contractor. The UPRVUNL may impose such restrictions on the facilities provided to the Contractor such as electricity, etc. as he may think fit in the interest of the UPRVUNL and the Contractor shall strictly adhere to such restrictions and co-operate with the UPRVUNL. It will be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and operation of the equipment systems which are erected by him. The Contractor shall also be responsible for flushing and initial filling of all the oil and lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in documents and specifications.

34.0 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

34.1 GENERAL

34.1.1 The Contractor upon completion of installation of equipments and system shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Contractor.

34.1.2 The pre-commissioning and commissioning activities including Guarantee tests, checks and trial operations of the equipment / systems furnished and installed by the Contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.

34.1.3 The following activities shall be carried out by the Contractor, eighteen (18) month prior to schedule date of commissioning of the equipments/systems installed by him.

- a) The Contractor shall furnish the organization chart of his operation and commissioning engineers for the acceptance of Owner. Adequate number of operation and commissioning engineers shall be deployed by the Contractor to effectively meet the requirement of round the clock operation in shifts also, till the plant is taken over by the Owner.



- b) The Contractor shall submit the bio-data containing the details of experience of his operation and commissioning engineers for the acceptance of Owner.
- c) The Contractor shall furnish the deployment schedule of his operation and commissioning engineers for the acceptance of the Owner.
- d) Apart from above, Contractor shall ensure deployment of sufficient skilled/semi-skilled/unskilled manpower during pre-commissioning and commissioning activities.
- 34.1.4 It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment / systems which are installed by him.
- 34.1.5 The Contractor shall also be responsible for flushing and initial filling of all oils and lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications and documents.
- 34.2 COMMISSIONING DOCUMENTATION
- 34.2.1 The Contractor shall submit the commissioning documentation, comprising of Standard checklists, pre-commissioning procedures, testing schedules, commissioning schedules and commissioning networks for various equipment / systems covered under the contract, for the approval of Owner.
- 34.2.2 Standard checklist, as the name suggests, shall be a fairly general documents, containing the list of all checks required to be carried out for similar and repetitive type of equipment to ensure consistent and thorough checking. An indicative list of such equipment is enclosed as Annexure 1.
- 34.2.3 The testing schedule is a document, designed for safe and systematic commissioning of individual equipment/sub-system (for example Boiler Feed Pump, condensate pump, compressor etc.) commissioning schedule is a document envisaged for commissioning of a system (for example feed system, Condensate system, Compressed Air System, Fire water system, Unit commissioning etc.). The testing / commissioning schedule shall have a standard format in order to maintain consistency of presentation, content and reporting. A brief write up on the contents of the Testing Schedule / Commissioning Schedule is enclosed as Annexure-II.
- 34.2.4 The Contractor shall submit the list of commissioning documentation to be submitted by him, alongwith their submission schedule for various equipment / systems covered under the contract, within six (6) months from the date of award of contract, for the acceptance of Owner.
- 34.2.5 The Contractor shall submit the commissioning documentation, for various equipment covered under the contract, for the approval of Owner at least 18 months before the scheduled date of commissioning of the equipment / systems.
- 34.3 COMMISSIONING ACTIVITIES



- 34.3.1 Upon completion of pre-commissioning activities/ tests, the contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carry out system checking and reliability trails on various parts of the facilities.
- 34.3.2 Contractor shall carry out the checks / tests at site to prove to the Owner that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified.
- 34.3.3 Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified / approved values. These tests may be conducted concurrently with those required under commissioning sequence.
- 34.3.4 The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment of prior to that as the case may be.
- 34.3.5 Other tests shall be conducted, if required by the Owner, to establish that the plant equipment is in accordance with requirements of the specifications.
- 34.3.6 The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all electrical and C&I equipment / systems not specifically brought out above but are within the scope of work and facilities being supplied and installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications.
- 34.4 Initial Operation
- Upon completion of system checking / Tests as above and as a part of commissioning of facilities, complete plant / facilities shall be put on initial operation as stipulated in Chapter -5 "General Technical Requirements".
- 35.0 MATERIALS HANDLING AND STORAGE
- 35.1 All the equipments furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.
- 35.2 Contractor shall be responsible for examining all the shipment and notify the UPRVUNL immediately of any damage, shortage, discrepancy etc. for the purpose of UPRVUNL's information only. The Contractor shall submit to the UPRVUNL every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damage in transit, handling and / or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 35.3 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the UPRVUNL.
- 35.4 All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the equipment without the specific written permission of the UPRVUNL. The

- equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at Site.
- 35.5 All electrical panels, controls gear, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.
- 35.6 All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and a record of such measured insulation values maintained by the Contractor. Such records shall be open for inspection by the UPRVUNL.
- 35.7 The Contractor shall ensure that all the packing materials and protection devices used for the various equipments during transit and storage are removed before the equipment are installed.
- 35.8 The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.
- 35.9 All the materials stored in the open or dusty location must be covered with suitable weatherproof and flame-proof covering material wherever applicable.
- 35.10 If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the UPRVUNL will have the right to get it moved to the area earmarked for the Contractor at the Contractor's cost.
- 35.11 The Contractor shall be responsible for making suitable indoor storage facilities to store all equipment which require indoor storage. Normally, all the electrical equipments such as motors, control gear, generators, exciters and consumables like electrodes, lubricants etc. shall be stored in the closed storage space. The UPRVUNL, in addition, may direct the Contractor to move certain other materials, which in his opinion will require indoor storage, to indoor storage areas which the Contractor shall strictly comply with.
- 36.0 CONSTRUCTION MANAGEMENT
- 36.1 The field activities of the Contractors working at Site, will be coordinated by the Owner and the Owner decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Owner regarding scheduling and co-ordination of work. Such decision by the Owner shall not be a cause for extra compensation or extension of time for the Contractor.
- 36.2 The Owner shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Owner. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Owner may call for other meeting either with individual Contractors or with selected



number of Contractors and in such a case the Contractor if called, will also attend such meetings.

36.3 Time is the essence of the Contract and the Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Owner, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

36.4 The Owner shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the coordination work between various Contractors as set out earlier.

37.0 FIELD OFFICE RECORDS

The Contractor shall maintain at his Site Office up-to-date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Owner in required number of copies.

38.0 CONTRACTOR'S MATERIALS BROUGHT ON TO SITE

38.1 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the Works under intimation to the UPRVUNL. All such goods shall, from the time of their being brought vest in the UPRVUNL, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the UPRVUNL. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.

38.2 The UPRVUNL shall have a lien on such goods for any sum or sums which may at any time be due or owing to him by the Contractor, under, in respect of or by reasons of the Contract. After giving a fifteen (15) days notice in writing of his intention to do so, the UPRVUNL shall be at liberty to sell and dispose off any such goods, in such manner as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfaction of such sum or sums due as aforesaid.

38.3 After the completion of the Works, the Contractor shall remove from the Site under the direction of the UPRVUNL the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the UPRVUNL. If the Contractor fails to remove such materials, within fifteen (15) days of issue of a notice by the UPRVUNL to do so then the UPRVUNL shall have the liberty to dispose off such materials as detailed under as specified at clause no 38.2 of this chapter and credit the proceeds thereto to the account of the Contractor.



39.0 PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

39.1 The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons including members of public and employees of the UPRVUNL and the employees of other Contractors and Sub- Contractors and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.

39.2 The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the UPRVUNL and the UPRVUNLs of public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such UPRVUNLs, related to removal and/or replacement or protection of such property and utilities.

40.0 PAINTING

For painting refer Chapter7-Painting in Vol-II.

Painting for piping shall also conform to the painting specification of the respective chapter.

Painting for Electrical equipments/systems shall conform to the painting specification given in Electrical portion of technical specifications.

41.0 INSURANCE

41.1 In addition to the conditions covered under the Clause entitled "Insurance" in Section-IV - General Conditions of Contract (GCC), the following provisions will also apply to the portion of works to be done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.

41.2 Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub- Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:

Workmen's Compensation	- As per Statutory Provisions
Employee's Liability	- As per Statutory Provisions

41.3 Comprehensive Automobile Insurance

This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the UPRVUNL's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the



Ownership of such vehicles. The liability covered shall be as herein indicated or as per the statutory requirement, whichever is higher:

Fatal Injury	:	Rs.100,000 each person
	:	Rs.200,000 each occurrence
Property Damage	:	Rs.100,000 each occurrence

41.4 Comprehensive General Liability Insurance

41.4.1 The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC).

41.4.2 The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.

41.4.3 The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.

42.0 UNFAVOURABLE WORKING CONDITIONS

The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms, etc. and during other unfavourable construction conditions. No field activities shall be performed by the Contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by the Contractor in a proper and satisfactory manner in the performance of such Works and with the concurrence of the UPRVUNL. Such unfavourable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the schedule

43.0 PROTECTION OF MONUMENTS AND REFERENCE POINTS

The Contractor shall ensure that any finds such as relic antiquity, coins, fossils, etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Owner. Similarly the Contractor shall ensure that the benchmarks, reference points, etc. which are marked either with the help of Owner or by the Owner shall not be disturbed in any way during the performance of his Works. If, any work is to be performed which disturb such reference, the same shall be done only after these are transferred to other suitable locations under the direction of the Owner. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc.

44.0 WORK & SAFETY REGULATIONS

44.1 General



- i) The contractor shall comply with all the requirements of "The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Act," 1996 and its Central Rule 1998 / State Rules, CEA Regulations on Safety Requirements (2011) and any other statutory requirements as applicable.
- ii) The Contractor shall follow UPRVUNL Safety Rules as issued from time to time with respect to safety in construction & erection.
- iii) The contractor shall have the approved Safety, Health and Environment (SHE) Policy in respect of Safety and health of Building Workers and it shall be circulated widely and displayed at conspicuous place in Hindi and local language understood by the majority of the workers. A copy of the safety policy should be submitted to Engineer in charge.
- iv) The contractor shall submit the safety plan comprising of methods to implement the Safety Policy/ Rules, Risk assessment and ensuring Safety at work areas, Safety audits, inspections and its compliance, Supervision and responsibility to ensure Safety at various levels, Safety training to employees, review of Safety and accident analysis, ensure Health and Safety Procedures to prevent accidents to Engineer I/C for approval. The typical format of Safety plan as annexed at Annexure - III. The Bidder shall also comply to the CEA Regulation on Safety Requirements, 2011.
- v) The Contractors shall ensure proper safety of all the workmen, materials, plant and equipment belonging to him or to the UPRVUNL or to others, working at the Site.
- vi) All equipments used in construction and erection by the contractor shall meet BIS / International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipments shall be strictly operated and maintained by the contractor in accordance with manufacturer's operation manual. The contractor should also follow Guidelines / Rules of the UPRVUNL in this regard.
- vii) The Contractors shall provide suitable latest Personal Protective Equipments of prescribed standard to all their employees and workmen according to the need. The Engineer I/c shall have the right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability. The contractor should also ensure these before their use at worksite.
- viii) The Contractor shall provide safe working conditions to all workmen and employees at his workplace including safe means of access, railings, stairs, and ladders, scaffolding, work platforms, toe boards etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection of scaffolds, access, work platforms etc. shall be good and the contractor shall use standard quality of material.
- ix) The Contractor shall follow and comply with all the Safety Rules,



standards, code of practices of UPRVUNL and relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any protest or contest or reservation. In case of any unconformity between statutory requirement and the Safety Rules of the UPRVUNL referred above, the latter shall be binding on the Contractor unless the statutory provisions are more stringent. As and when required he can refer / obtain copy of UPRVUNL safety documents as stated above.

- x) The contractor shall have his own arrangements with nearby hospitals for shifting and treatment of sick and injured.

The medical examination of the workers employed in hazardous areas shall be conducted as per Rule 223 Of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 their health records shall be maintained accordingly and to be submitted to Engineer I/c when asked for. If any worker found suffering from occupational health hazard, the worker should be shifted to suitable place of working and properly treated under intimation to Engineer I/c. The medical fitness certificate to be submitted to Engineer (I/c).

- xi) First Aid boxes equipped with requisite articles as specified in the Rule 231 of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 shall be provided at construction sites for the use of workers. Training has to be provided on first aid to workmen & office bearers working at site.

44.1.1 Emergency Action Plan

The contractor shall prepare an emergency action plan approved by his competent authority to handle any emergency occurred during construction work. Regular mock drills shall be organized to practice this emergency plan. The Emergency Action Plan should be widely circulated to all the employees and suitable infrastructure shall be provided to handle the emergencies.

44.1.2 Scaffolding

The contractor shall take all precautions to prevent any accidental collapse of scaffolding or fall of persons from scaffolding. The contractor should ensure that scaffolding are designed by a competent person and its erection and repairs should be done under the expert supervision. The scaffolding shall meet the required strength and other requirements for the purpose for which the scaffold is erected. The material used for scaffold should conform to the BIS / International standards.

44.1.3 Opening

The contractor shall ensure that there is no opening in any working platform/any floor of the building, which may cause fall of workers or material. Whenever an opening on a platform/any floor of the building is unavoidable, the opening should be suitably fenced and necessary measures for protection against falling objects or building workers from such platform are taken by providing suitable safety nets, safety belts or other similar means.



44.1.4 Explosives

The contractor shall take all precautions while handling, using, storing or transporting of all explosives. Before usage of any explosive necessary warning / danger signals be erected at conspicuous places to warn the workers and general public. The contractor should strictly ensure that all measures and precautions required to be complied for use, handling, storing or transportation of explosives under the rules framed under the Explosives Act, 1884.

44.2 Fencing of Machinery

The contractor shall provide suitable fencing or guard to all dangerous and moving parts of machinery.

The contractor shall not allow any of the employees to clean, lubricate, repair, adjust or examine during machinery in motion, which may cause injury to the person.

44.3 Carrying of Excessive Weight by a Worker

The worker shall not be allowed to lift by hand or carry over his head back or shoulder more than the maximum limit set by the prescribed rules for the construction Workers.

44.4 Dangerous and Harmful Gases / Equipment

The contractor shall ensure that the workers are not exposed to any harmful gases during any construction activity including excavation, tunnelling, confined spaces etc.

The contractor should not allow any worker to go into the confined space unless it is certified by Engineer (I/c) to be safe and fit for the entry to such work place. Proper record and work permits should be followed to carry out such works.

44.5 Overhead Protection

The contractor shall ensure that any area exposed to risk of falling materials, articles or objects is roped off or cordoned off or otherwise suitably guarded from inadvertent entry of any person.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

44.6 Working at Heights

All working platforms, ways and other places of construction work shall be free from accumulations of debris or any other material causing obstructions and tripping.

Wherever workers are exposed to the hazard of falling into water, the contractor shall provide adequate equipment for saving the employees from drowning and rescuing from such hazards. The contractor shall provide boat or



launch equipped with sufficient number of life buoys, life jackets etc. manned with trained personnel at the site of such work.

Every opening at elevation from ground level through which a building worker, vehicle, material equipment etc. may fall at a construction work shall be covered and/or guarded suitably by the contractor to prevent such falls.

Wherever the workers are exposed to the hazards of falling from height, the contractor shall provide full harness safety belts fitted with fall arresting systems to all the employees working at higher elevations and life line of 8 mm diameter wire rope with turn buckles for anchoring the safety belts while working or moving at higher elevations. Safety nets shall also be provided for saving them from fall from heights and such equipment should be in accordance with BIS standards.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

The contractor shall provide standard prefabricated ladders on the columns where the workers are required to use them as an access for higher elevations till permanent staircase is provided. The workers shall be provided with safety belts fitted with suitable fall arresting system (Fall arrestors) for climbing/getting down through ladders to prevent fall from height.

44.7 Handling of Hazardous Chemicals

The Contractor will notify well in advance to the Engineer I/c of his intention to bring to the Site any container filled with liquid or gaseous fuel or explosive or petroleum substance or such chemicals which may involve hazards. UPRVUNL shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the works and the Contract shall strictly adhere to and comply with such instructions. The Engineer I/c shall have the right at his sole discretion to inspect any such container or such construction plant / equipment for which material in the container is required to be used and if in his opinion, its use is not safe, he may forbid its use. No claim due to such prohibition shall be entertained by UPRVUNL and UPRVUNL shall not entertain any claim of the Contractor towards additional safety provisions / conditions to be provided for / constructed.

Further, any such decision of the Engineer I/c shall not, in any way, absolve the Contractor of his responsibilities and in case, use of such a container or entry thereof into the Site area is forbidden by UPRVUNL, the Contractor shall use alternative methods with the approval of the UPRVUNL without any cost implication to the UPRVUNL or extension of work schedule.

Where it is necessary to provide and / or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying-out such provision and / or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the Engineer I/c. In case any approvals are necessary from the Chief Inspector (Explosives) or any statutory authorities, the Contractor shall be responsible for obtaining the same.



The Contractor shall be fully responsible for the safe storage of his and his Sub-contractor's radio-active sources in accordance with BARC/DAE (Bhabha Atomic Research Centre/ Department of Atomic Energy, Govt. of India) Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE in connection with use, the contractor would take storage and handling of such material.

The contractor shall provide suitable personal protective equipments to the workers who are handling the hazardous and corrosive substances including alkalis and acids.

As a precautionary measure the contractor should keep the bottles filled with distilled water in cupboard/Boxes near work place for emergency eye wash by worker exposed to such hazardous chemicals.

44.8 Eye Protection

The contractor shall provide suitable personal protective equipment to his workmen depending upon the nature of hazards and ensure their usage by the workers engaged in operations like welding, cutting, chipping, grinding or similar operations which may cause injuries to his eyes.

44.9 Excavation

The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding material or article from any bank or side of such excavation which is more than one and a half meter above his footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

44.10 Electrical Hazards

The contractor should ensure that all electrical installations at the construction work comply with the requirements of latest electricity acts / rules.

The contractor shall take all adequate measures to prevent any worker from coming into physical contact with any electrical equipment or apparatus, machines or live electrical circuits which may cause electrical hazards during the construction work. The contractor shall provide the sufficient ELCBs / RCCBs for all the portable equipments, electrical switchboards, distribution panels etc. to prevent electrical shocks.

The contractor should ensure use of single / double insulated hand tools or low voltage i.e., 110 volts hand tools.

The contractor should also ensure that all temporary electrical installations at the construction works are provided with earth leakage circuit breakers.

44.11 Vehicular Traffic



The contractor should employ vehicle drivers who hold a valid driving license under the Motor Vehicles Act, 1988.

44.12 Lifting Appliances, Tools & Tackles, Lifting Gear And Pressure Plant & Equipment etc.

The contractor shall ensure all the lifting appliances, tools & tackles including cranes etc., lifting gear including fixed or movable and any plant or gear, hoists, Pressure Plant and equipment etc. are in good condition and shall be examined by competent person and only certified shall be used at sites. Periodical Examination and the tests for all lifting / hoisting equipment & tackles shall be carried out. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by the Engineer I/c or by the person authorized by him.

44.13 Excessive Noise, Vibration

The contractor shall take adequate measures to protect the workers against the harmful effect of excessive noise or vibration. The noise should not exceed the limits prescribed under the concerned rules, Noise Pollution (Regulation and Control) Rules, 2000.

44.14 Electrical Installations

The Contractor shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to the UPRVUNL or other contractors under any circumstances, whatsoever, unless expressly permitted in writing by the Engineer I/c to handle such fuses, wiring or electrical equipment.

Before the Contractor connects any electrical appliances to any plug or socket belonging to the other contractor or the UPRVUNL, he shall

- i.) Satisfy the Engineer I/C that the appliance is in good working condition;
- ii.) Inform the Engineer I/C of the maximum current rating, voltage and phases of the appliances;
- iii.) Obtain permission of the Engineer I/C detailing the sockets to which the appliances may be connected.

The Engineer I/C will not grant permission to connect until he is satisfied that:

- a. The appliance is in good condition and is fitted with suitable plug; having earth connection with the body.
- b. Wherever armoured / metallic sheathed multi core cable is used, the same armoured / sheathed should be connected to earth.
- iv.) No repair work shall be carried out on any live equipment. The Engineer I/c must declare the equipment safe and a permit to work shall be issued by the UPRVUNL / contractor as the case may be to carry out any repair / maintenance work. While working on electric lines / equipments whether live or dead, suitable type and sufficient quantity of tools will have to be provided by the contractor to electricians / workmen / Officers.



- v.) The contractor shall employ necessary number of qualified, full time Electricians/ Electrical Supervisors to maintain his temporary electrical installation.

The installations are provided with suitable ELCBs and RCCBs wherever required.

44.15 Safety Organisation

- 44.15.1 The contractor employing more than 250 workmen whether temporary, casual, probationary, regular or permanent shall employ at least one full time safety officer exclusively to supervise safety aspects of the equipments and workmen, who will coordinate with the UPRVUNL Safety Officer. Further requirement of safety officers, if any, shall be guided by Rule 209 of The Building and Other Construction Worker (Regulation of Employment and Conditions of Service) Central Rule 1998. In case the work is being carried out through subcontractor, the employees / workmen of the sub contractor shall also be considered as the contractor's employees/workmen for the above purpose.

In case of contractor deploying less than 250 workmen he should designate one of his Engg /supervisor or the contractor himself (if he is directly supervising the work) as safety officer in addition to his existing responsibilities. The Engg/ supervisor should get at least 2days safety training from any reputed organization or from UPRVUNL before resuming the work. If already trained in past the declaration along with trg. certificate to be furnished to UPRVUNL safety officer.

- 44.15.2 The name and address of such Safety Officer of the Contractor will be promptly informed in writing to the EIC with a copy to the Project Safety Officer before he starts work or immediately after any change of the incumbent is made during currency of the Contract.

44.16 Reporting of Accident and Investigation

In case any accident occurs during the construction / erection or other associated activities undertaken by the Contractor thereby causing any near miss, minor or major or fatal injury to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engineer I/C, UPRVUNL Safety Officer with a copy to UPRVUNL Head of Project in the prescribed form and also to all the authorities envisaged under the applicable laws.

44.17 Right to stop Work

- 44.17.1 The Engineer I/C shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the contractor shall be informed in writing about the nature of hazards and possible injury / accident and he shall comply to remove shortcomings promptly. The Contractor after stopping the specific work can, if felt necessary appeal against the order of stoppage of work to the Project Manager within 3 days of such stoppage of work and decision of the Project Manager in this respect shall be conclusive and binding on the Contractor.



4.17.2 The Contractor shall not be entitled for any damages / compensation for stoppage of work, {Sub-Clause XVIII (I)} due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Facilities and will not be the ground for waiver of levy of liquidated damages.

44.18 Fire Protection

The contractor shall provide sufficient fire extinguishers at place /s of work. The fire extinguishers shall be properly maintained as per relevant BIS Standards. The employees shall be trained to operate the fire extinguishers / equipment.

44.19 Penalties

a) If the Contractor fails in providing safe working environment as per the Safety Rules of UPRVUNL or continues the work even after being instructed to stop the work by the Engineer I/C as provided the Contractor shall be penalized at the rate of Rs. 25,000/- per day or part thereof till the instructions are complied with and so certified by the Engineer I/C. However, in case of accident, the provisions contained below shall also apply in addition to the penalties mentioned in this sub-clause.

b) If the Contractor does not take all safety precautions and / or fails to comply with the Safety Rules as prescribed by the UPRVUNL or under the applicable law for the safety of the plant and equipment and for the safety of personnel and the contractor does not prevent hazardous conditions which cause injury to his own employees or employees of other contractors, or UPRVUNL's employees or any other person who are at the Site or adjacent thereto, the Contractor shall be responsible for payment of penalty as per the following schedule:-

i. Fatal injury or accident causing death:

Penalty @10% of contract value or Rs. 5,00,000/- per person, whichever is less.

ii. Major injuries or accident causing 25% or more permanent disablement to workmen or employees:

Penalty @2.5% of contract value or Rs. 1,00,000/- per person whichever is less

Permanent disablement shall have the same meaning as indicated in 'The Workmen's Compensation Act' 1923.

The penalty mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the 'The Workmen's Compensation Act 1923' and rules framed there under or any other applicable laws as applicable from time to time.

c) If any contractor worker found working without using the safety equipment like safety helmet, safety shoes, safety belts, etc. or without anchoring the safety belts while working at height the Engineer I/C / Safety Officer of UPRVUNL shall have the right to penalize the contractor for Rs. 200/-



per person per day and such worker shall be sent out of the workplace immediately and shall not be allowed to work on that day. Engineer I/C / Safety Officer of UPRVUNL will also issue a notice in this regard to the contractor.

- d) If two or more fatal accidents occur at same UPRVUNL site under the control of contractor during the period of contract and he has
- i. not complied with keeping adequate PPEs in stock or
 - ii. defaulted in providing PPEs to his workmen
 - iii. not followed statutory requirements / UPRVUNL safety rules
 - iv. been issued warning notice/s by UPRVUNL head of the project on non observance of safety norms
 - v. Not provided safety training to all his workmen, the contractor can be debarred from getting tender documents in UPRVUNL for two years from the date of last accident.
- e) The safety performance will also be one of the overriding criteria for evaluation of overall performance of the contractors by UPRVUNL. The contractor shall submit the accident data including fatal / non-fatal accidents for the last 3 years where he has undertaken the construction activities Projects-wise along with the tender documents. This will also be considered for evolution of tender documents. If the information given by the contractor found incorrect, his contract will be liable to be terminated.

44.20 Award

If the Contractor's performance on safety front is found satisfactory i.e. without any fatal/reportable accident in the year of consideration he may be considered for suitable award "ACCIDENT FREE SAFETY MERITORIOUS AWARD" as per scheme of the UPRVUNL.

45.0 FOREIGN PERSONNEL

45.1 The Contractor shall submit to the UPRVUNL data on all personnel he proposes to bring into India from abroad for the performance of the Works under the Contract, at least sixty (60) days prior to their departure to India. Such data will include for each person the name, his present address, his assignment and responsibility in connection with the works, and a short resume of his qualification, experience etc. in relation to the work to be performed by him.

45.2 Any person unsuitable and unacceptable to the UPRVUNL shall not be brought to India. Any person brought to India, if found unsuitable or unacceptable by the UPRVUNL, the Contractor shall within a reasonable time make alternate arrangements for providing a suitable replacement and repatriation of such unsuitable personnel.

45.3 No person brought to India for the purposes of the works shall be repatriated without the consent of the UPRVUNL in writing, based on a written request from the Contractor for such repatriation giving reasons for such an action to the UPRVUNL. The UPRVUNL may give permission for such repatriation provided he is satisfied that the progress of work will not suffer due to such repatriation.



- 45.4 The cost of passports, visas and all other travel expenses to and from India, incurred by the Contractor shall be to his account. The UPRVUNL will not provide any residential accommodation and/or furniture for any of the Contractor's personnel including foreign personnel and Contractor shall make his own arrangements for such facilities in the area allotted at Site, to him by the UPRVUNL for that purpose.
- 45.5 The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, rules and regulations and shall not in any way interfere with Indian political and religious affairs and shall conform to any other rules and regulations which the Government of India and the UPRVUNL may establish from time to time, on them. The Contractor's expatriate personnel shall work and live in close co-operation and coordination with their co-workers and the community and shall not engage themselves in any other employment neither part-time nor full-time nor shall they take part in any local politics.
- 45.6 The UPRVUNL shall assist the Contractor, to the extent possible, in obtaining necessary permits to travel to India and back, by issue of necessary certificates and other information needed by the Government agencies
- 46.0 FOUNDATION DRESSING & GROUTING FOR EQUIPMENTS/EQUIPMENTS BASES
- 46.1 The surfaces of foundations shall be dressed to bring the top surface of the foundations to the required level, prior to placement of equipment / equipment basis on the foundations.
- 46.2 All the equipment / equipment bases, shall be grouted and finished as per these specifications unless otherwise recommended by the equipment manufacturer.
- 46.3 The concrete foundation surfaces shall be properly prepared by chipping, grinding as required to bring the top of such foundation to the required level, to provide the necessary roughness for bondage and to assure enough bearing strength.
- 46.4 Grout
- 46.4.1 The grout shall be high strength grout having a minimum characteristic compressive strength of 60 N/mm² at 28 days from being cast. The grout shall be chloride free, cement based, free flowing, non-metallic grout.
- 46.4.2 The grout shall have good flow ability even at very low water / grout powder ratio.
- 46.4.3 The grout shall have characteristics of controlled expansion to be able to occupy its original volume to fill the voids and to compensate for shrinkage. Grout shall be of pre-mix variety so that only water needs to be added before use.
- 46.4.4 The mixing of the Grout shall conform to the recommendations of the manufacturer of the Grout.



- 46.5 Placing of Grout
- 46.5.1 After the base has been prepared, its alignment and level has been checked and approved and before actually placing the grout, a low dam shall be set around the base at a distance that will permit pouring and manipulation of the grout. The height of such dam shall be at least 25 mm above the bottom of the base. Suitable size and number of chains shall be introduced under the base before placing the grout, so that such chains can be moved back & forth to push the grout into every part of the space under the base.
- 46.5.2 The grout shall be poured either through grout holes if provided or shall be poured at one side or at two adjacent sides to make the grout move in a solid mass under the base and out in the opposite side. Pouring shall be continued until the entire space below the base is thoroughly filled and the grout stands at least 25mm higher all around than the bottom of the base. Enough care should be taken to avoid any air or water pockets beneath the bases.
- 46.5.3 In addition to the above, recommendations of Grout manufacturer shall also be followed.
- 46.6 Finishing of the Edges of the Grout
- 46.6.1 The poured grout should be allowed to stand undisturbed until it is well set. Immediately thereafter, the dam shall be removed and grout which extends beyond the edges of the structural or equipment base plates shall be cut off, flushed and removed. The edges of the grout shall then be pointed and finished with 1:2 cement mortar pressed firmly to bond with the body of the grout and smoothed with a tool to present a smooth vertical surface. The work shall be done in a clean and scientific manner and the adjacent floor spaces, exposed edges of the foundations, and structural steel and equipment base plates shall be thoroughly cleaned of any spillage of the grout.
- 46.7 Checking of Equipment after Grouting
- 46.7.1 After the grout is set and cured, the Contractor shall check and verify the alignment of equipments, alignment of shafts of rotating machinery, the slopes of all bearing pedestals, centering of rotors with respect to their sealing bores, couplings, etc. as applicable and the like items to ensure that no displacement had taken place during grouting. The values recorded prior to grouting shall be used during such post grouting check-up and verifications. Such pre and post grout records of alignment details shall be maintained by the Contractor in a manner acceptable to the Owner.
- 47.0 SHAFT ALIGNMENTS
- All the shafts of rotating equipment shall be properly aligned to those of the matching equipments to as perfect an accuracy as practicable. The equipment shall be free from excessive vibration so as to avoid overheating of bearings or other conditions which may tend to shorten the life of the equipment. The vibration level of rotating equipments measured at bearing housing shall conform to Zone A of ISO 10816. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.
- 48.0 DOWELLING

All the motors and other equipment shall be suitably dowelled after alignment of shafts with tapered machined dowels as per the direction of the Owner.

49.0 CHECK OUT OF CONTROL SYSTEMS

After completion of wiring, cabling furnished under separate specification and laid and terminated by the UPRVUNL, the Contractor shall check out the operation of all control systems for the equipment furnished and installed under these specifications and documents.

50.0 COMMISSIONING SPARES

50.1 It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the completion of facilities. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Owner and mutually agreed to. However, such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Owner.

50.2 These spare will be received and stored by the Contractor at least three (3) months prior to the schedule date of commencement of initial operation of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Owner.

51.0 CABLING

51.1 All Cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed and exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends or fittings. When cables are run on cable trays, they shall be clamped at minimum intervals of 2000mm or otherwise as directed by the Owner.

51.2 Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both ends of the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.

51.3 Sharp bending and kinking of cables shall be avoided. The minimum radii for PVC insulated cables 1100 V grade shall be 15D (where D is the overall diameter of the cable). Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gas lines, special care should be taken for the protection of the cables in designing the cable channels.

51.4 In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should be cable develop fault at a later date.



- 51.5 Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to the Owner's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable, as far as possible, to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilizing plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly cut.
- 51.6 The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.
- 52.0 EQUIPMENTS DELIVERY AND ERECTION
- 52.1 General Requirements
- a) This part covers Contractor's responsibilities for packing, shipping, warehousing and the installation of all equipment and materials furnished and installed under this specification.
 - b) The Contractor shall submit for Owner's approval draft manual for Equipment Delivery and Erection (EDE Manual) covering detailed instructions, write-up, technical data, drawings, check-lists, documentation formats for all activities after equipment manufacture upto installation of equipment. This manual shall cover general instructions for all equipment and specific instructions for individual equipment wherever required and shall include at least the following:
 1. Instructions for packing, shipping, receiving handling, warehousing and storage.
 2. Instructions for location and installation of equipment furnished by this specification.
 3. Installation drawings for field mounted equipment, panels, cubicles and other equipment covered under this specification.
 4. Instruction relating installation of piping/tubing, support and routing drawings of impulse pipes / signal tubes and tube/cable trays.
 5. Check lists and quality assurance hold point.
 6. Format for all related documentation.
 - c) The EDE Manual shall conform to the requirements of this specification, all applicable codes and standards, recommendations of equipment manufacturers and accepted good engineering practices and shall be subject to Owner approval during detailed engineering.
 - d) The Contractor shall ensure that all work under this part shall be performed as per the requirements of this specification. Owner approved EDE Manual and drawing / documents approved by the Owner during detailed engineering.

52.2 Crating



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- b) All equipment and materials shall be suitably coated, wrapped, or covered and boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.
- c) Equipment shall be packed with suitable desiccants, sealed in water proof vapour-proof wrapping and packed in lumber of plywood enclosures, suitably braced, tied and skidded. Lumber enclosures shall be solid, not slatted.
- d) Descants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers, strong enough to withstand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in wrapping.
- e) Review by the Owner of the Contractor's proposed packaging methods shall not relieve the Contractor of responsibility for damage or deterioration to the equipment and materials specified.
- f) All accessory items shall be shipped with the equipment. Boxes and crates containing accessory items shall be marked so that they are identified with the main equipment. The contents of each box and crates shall be indicated by markings on the exterior.
- g) All boxes, crates, cases bundles, loose pieces, etc. shall be marked consecutively from No.1 upward throughout all shipments from a given port to completion of the order without repeating the same number.
- h) An itemized list of contents shall be enclosed inside each case and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc. according to its individual shipping number:
 - 1. Export case markings
 - 2. Case number
 - 3. Gross weight and net weight in Kilograms
 - 4. Dimensions in centimeters
 - 5. Complete description of material
- i) Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. Complications involved with ocean shipment and the limitations of ports, railways and roads shall be considered. It shall be the Contractor's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.
- j) Electrical equipment, control and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearing and like items shall be



thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

- k) Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.
- l) Coated surfaces shall be protected against impact, abrasion, discolouration and other damage. Surfaces which are damaged shall be repaired.
- m) All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All pipings, tubing, and conduit equipment and other equipment openings shall be sealed with metallic or other rough usage covers and tapped to seal the interior of the equipment piping, tubing, or conduit.
- n) Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.
- o) Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.
- p) While packaging the material, care shall be taken for the limitation from the point of view of availability of railway wagon sizes in India.

52.3 Factory Assembly

- a) Instrument enclosures shall be supplied and erected completely in the factory with instrument, air supply and blow down piping with necessary valves, fittings, etc. and also all electrical wiring between the instruments and the enclosure terminal blocks. Control panel and cubicles shall also be fully wired in the factory. Control panel mounted equipments are to be dismantled from the panels before shipment and individually packed for shipment. Electronic control modules of the plug-in type are to be removed from equipment racks after factory checkout are individually packed for shipment. Other equipment shall be fully assembled at the factory, except for necessary shipping splits in panels.
- b) All separately packaged accessories items and part shall be shipped with the equipment. Containers for separately packaged items shall be marked so that they are identified with the main equipment. An itemized packing slip, indicating what is in that carton only, shall be attached to the outside and inside of each container used for packing.
- c) A master packing slip covering all accessories items for a given piece of equipment which are shipped in separate containers, shall be attached to one container.

52.4 Equipment Installation

a) General Requirements

1. The Contractor shall furnish all construction materials, tools and equipment and shall perform all work required for complete installation



of all control and instrument equipment furnished under this specification.

2. Contractor shall prepare detailed installation drawings for each equipment furnished under this specification for Owner's approval. Installation of all equipment/systems furnished by this specification shall be as per Owner's approval.

3. Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Owner.

4. The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.

b) Installation Materials

All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.

c) Regulator Requirements

All installation procedures shall confirm with the accepted good engineering practice and with all applicable government laws, regulations and codes.

d) Cleaning

All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is brought inside the power plant building or to other installation sites. All piping and tubes shall be air blown.

e) Equipment Assembly

Equipment installed under these specifications shall be assembled if shipped unassembled. The equipment shall be dismantled and reassembled as required to perform the installation and commissioning work described in these specifications.

f) Equipment Setting

Field mounted instruments and accessories shall be bracket or sub panel mounted on the nearest suitable firm steel work or masonry. The brackets, stands, supports and other miscellaneous hardware required for mounting instruments and accessories such as receiver gauge, air set, valve manifold, purge-meter etc. shall be furnished and installed. No field mounted instruments shall be installed such that it depends for support or rigidity on the impulse piping or on electrical connection to it.

Indicating type field mounted instruments shall be installed in such a way that centre of indicating dial shall be about 1600-1800 mm from operating floor level. Non-indicating type field instruments shall be installed such that operating handle of manifold block/isolating cock comes within 1600mm from operating floor level.

All free standing instrumentation cabinets and panels shall be located within the construction tolerances of +/- 3mm of the location dimensions indicated on the Owner's plant arrangement drawings.

g) Free Standing Equipment



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Free-standing Cabinets shall be attached to the floor, concrete equipment bases or supporting steel as indicated on the manufacturer's drawings and the Owner's Plant Arrangement Drawings. The cabinets shall be shimmed for proper alignment before bolting them to the floor. Adjacent enclosures shall be shimmed to maintain mutually level appearance before they are attached to floor. Vibration dampening mounts shall be installed between supporting structures and panels when specified.

h) Non-free Standing Equipment

1. Non-free standing local enclosures and cabinets shall be mounted in accessible locations on columns, walls, or stands in locations as indicated on the Owner's Plant Arrangement Drawings. Bracket and stands shall be fabricated as required to install the local enclosures and cabinets in a workman like manner.
2. Rough edges and welds on all fabricated supports shall be ground smooth. The supports shall be finished with two coats of primer and two coats of paint as specified in this part.

i) Equipment Location

1. All individual items of equipment not located in cabinets or on panels and racks are located approximately according to the floor elevation and the nearest building column designated by the Owner.
2. Solenoid valves not located in enclosures or mounted on valves shall be mounted in easily accessible protected locations near the components with which they are associated.
3. All brackets, stands, supports and other miscellaneous hardware required for mounting devices shall be furnished and installed.
4. Thermometers shall be installed in the process lines and ducts as required and adjusted for ease in reading.
5. Permanent temperature wells on the main steam, hot reheat and cold reheat piping shall not be installed until steam blowing has been completed. Temporary temperature wells shall be installed in the main and reheat steam piping during steam blow and discarded after completion.
6. Any required adapting hardware such as pipe bushings, nipples, drilled caps and the like shall be provided for complete installation of control devices into process connections.
7. For location of C&I related equipment/devices, the requirement specified elsewhere in the technical specification may be referred.

j) Installation of Field Mounted Instruments and devices

The Contractor shall submit installation drawings for all field mounted equipment furnished under this specification for Owner's approval. These drawings shall meet the requirements of this specification, installation drawings, applicable codes and standards and recommendations of manufacturers of instruments / devices. All installation work under this



specification shall be strictly as per installation drawings approved by the Owner during detailed engineering stage.

In addition to above relevant Portion as specified elsewhere in technical specification may be referred.

k) Piping Connections

1. All equipment having piping connections shall be leveled, aligned and wedged in place but shall not be grouted or bolted prior to the initial fitting and alignment of connecting piping. All equipment shall, however, be grouted or bolted to its foundation prior to final bolting or welding of the connection piping.
2. All flanged joints shall be checked and retightened after approximately 10 days of operation at normal operating temperature.

l) Equipment Checkout

1. All equipment shall be cleaned after installation. Equipment subject to pressure differentials shall be checked for leakage.
2. After erection, all equipment having moving parts, having electrical apparatus, or subject to pressure differentials shall be trial-operated.

m) Defects

1. All defects in erection shall be corrected to the satisfaction of the Owner and the Project Manager. The dismantling and reassembly of Contractor furnished equipment to remove defective parts, replace parts, or make adjustments shall be included as a part of the work under these specifications.
2. The removal of control and instrument equipment in order to allow bench calibration, if required, and the re-installation of the said equipment after calibration shall also be included as a part of the work under these specifications.

n) Equipment Protection

1. All equipment to be erected under these specifications shall be protected from damage of any kind from the time of contract award until commissioning of each unit.
2. The equipment shall be protected during storage as described herein.
3. Equipment shall be protected from weld spatter during construction.
4. Suitable guards shall be provided for protection of personnel on all exposed rotating or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy removal and maintenance.
5. Equipment has glass components such as gauges, or equipment having other easily breakable components, shall be protected during the



construction period with plywood enclosures or other suitable means. Broken, stolen, or lost components shall be replaced by the Contractor.

6. Machine finished surfaces, polished surfaces, or other bare metal surfaces which are not to be painted, such as machinery shafts and couplings shall be provided temporary protection during storage and constructional periods by a coating of a suitable non-drying, oily type, rust preventive compound.

53.0 WELDING - SPECIAL REQUIREMENTS

If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed under separate specifications, the requirements shall be submitted to the Project Manager in advance of commencement of erection work.

54.0 DEVIATIONS DISPOSITIONING

Any deviation to the contract and UPRVUNL approved documents shall be properly recorded in the format prescribed by UPRVUNL. All the deviations shall be brought to the knowledge of UPRVUNL's representative for suitable dispositioning.

55.0 NON-DESTRUCTIVE TESTING (NDT)

The contractor shall record results of NDTs carried out at site in the format acceptable to UPRVUNL. All the radiographs & its report duly signed & correlated to the job shall be handed over to the UPRVUNL. Sensitivity of all the test equipment shall be compatible to the job & acceptance norms agreed.

56.0 TESTING EQUIPMENT & FACILITIES

Contractor shall provide the testing equipment and facilities necessary to carry out tests & inspections.

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ANNEXURE-I

STANDARD CHECKLIST
COMMISSIONING/TESTING ESSENTIAL PRE-REQUISITE

1. MECHANICAL

A) VALVES

- 1) MANUALLY OPERATED VALVE
- 2) ELECTRICALLY OPERATED VALVE
- 3) PNEUMATICALLY ACTUATED VALVE
- 4) HYDRAULICALLY ACTUATED VALVE
- 5) SAFETY VALVE
- 6) ELECTROMATIC RELIEF VALVE
- 7) STEAM TRAP
- 8) BUTTERFLY VALVE (ELECTRICALLY OPERATED)
- 9) BUTTERFLY VALVE (MANUALLY OPERATED)
- 10) BUTTERFLY VALVE (FOUR WAY-ELECTRICAL)
- 11) NON-RETURN VALVE (INCLUDING HYDRAULIC/PNEUMATIC FCNRVS)
- 12) THREEWAY CONTROL VALVE
- 13) RELIEF VALVE
- 14) DIFFERENTIAL PRESSURE REGULATING VALVE
- 15) FLOAT OPERATED VALVES

B) TANKS AND PRESSURE VESSELS

- 1) TANKS (METAL) UP TO 20M²
- 2) TANKS (LARGE STORAGE)
- 3) PRESSURE VESSEL (BELOW 17 BARS)
- 4) AIR RECEIVER
- 5) PRESSURE VESSEL-ACCESS DOOR
- 6) TURBINE MAIN OIL TANK

C) PUMPS

- 1) PUMP LOW PRESSURE CENTRIFUGAL (MOTOR DRIVEN)
- 2) PUMP UP TO 350 HP (260 KW)
- 3) PUMP SUMP INSTALLATION
- 4) GEAR PUMP/SCREW PUMP

D) PIPE WORK SYSTEM

- 1) STEAM SERVICES
- 2) WATER SERVICES
- 3) OIL/FIRE RESISTANT FLUIDS SYSTEM
- 4) AIR SERVICES (COMPRESSOR)
- 5) HIGH PRESSURE SERVICES
- 6) CONSTANT LOAD SUPPORT
- 7) SPRING SUPPORTS
- 8) HANGERS AND OTHER SUPPORTS

E) STRAINER AND FILTER

- 1) STRAINER/FILTER BASKET TYPE
- 2) STRAINER ROTARY (LOW PRESSURE)
- 3) FILTER & STRAINERS CENTRIFUGAL SEPARATORS
- 4) FILTER & STRAINER Y-TYPE



- 5) FILTER&STRAINER(PLATETYPE)
- 6) PURIFIER
- 7) FILTER-COMPRESSED AIRLINE
- F) HEATEXCHANGER
 - 1) HEATEXCHANGER(GENERAL)
 - 2) HEATEXCHANGER-OIL/WATER
 - 3) ROTARYAIR HEATER
- G) FANSANDCOMPRESSORS
 - 1) FANS-NON-PRESSURELUBRICATED
 - 2) FANS-AXIALFLOWPRESSURELUBRICATED
 - 3) COMPRESSORS-GENERAL
 - 4) DAMPERS&GATES
- H) CRANESANDELEVATORS
 - 1) AUXILIARYOVERHEADCRANE
 - 2) TRAVELSUPPORTSTRUCTURE FORCRANE
 - 3) LONGTRAVEL&CROSS TRAVERSE MOTION OF CRANE
 - 4) MAINAUX. HOIST MOTION (CRANE)
 - 5) ELECTRIC HOIST
- I) POWER TRANSMISSION
 - (1.) POWER TRANSMISSION GEARBOX (2.) BEARING
 - (2.) BEARING
 - (3.) FLUID COUPLINGS
2. ELECTRICAL
 - 1) D.C.MOTOR
 - 2) HVSQUIRREL CAGE INDUCTION MOTOR
 - 3) 415V SQUIRREL CAGE INDUCTION MOTOR
 - 4) MOTOR OPERATED ACTUATORS
 - 5) LT SWITCHGEARS/MCC
 - i) STANDARD CHECKLISTS FOR ALL TYPES OF RELAYS USED IN SWITCHGEARS PROTECTION SYSTEM
 - ii) PTCARRIAGE AND CUBICLES
 - iii) CABLE/BUS DUCT/BUSBARS
 - iv) CONTRACTOR MODULE
 - v) SWITCH FUSE MODULE
 - vi) MASTER PANEL OF LUBEOIL PANEL
 - vii) FEEDER PANEL OF LUBEOIL PANEL
 - viii) SPACE HEATER AND CABLE MODULE
 - ix) CONTROL TRANSFORMER MODULE
 - x) HT CIRCUIT BREAKER
 - xi) 415V CIRCUIT BREAKER
 - 6) POWER CABLE
 - 7) CONTROL CABLE
 - 8) AUXILIARY CABLE
 - 9) D.C. CABLE
 - 10) EXPLOSION PROOF ELECTRICAL EQUIPMENT
 - 11) JUNCTION BOX
 - 12) CONTROL TRANSFORMER MODULE
 - 13) BRUSH GEAR ASSEMBLY



- 14) AUX.CONTROLANDRELAYPANELDESK
- 15) INDICATINGINSTRUMENT
- 16) RECORDINGINSTRUMENT
- 17) INTEGRATINGINSTRUMENT

3. CONTROL & INSTRUMENTATION

- A) CONDUCTIVITY ANALYSING EQUIPMENT INCLUDING TEST PROCEDURES
- B) PHANALYSERINCLUDINGTESTPROCEDURE
- C) SILICAANALYSER
- D) LEVELSWITCH(FLOATACTUATED)
- E) LEVELSWITCH(ELECTRODETYPE)
- F) LEVELSWITCH(DISPLACERACTUATED)
- G) TRANSMITTER(FLOATOPERATEDPNEUMATICOUTPUT)INCLUDING TESTINGPROCEDURE
- H) LEVELINDICATOR(FLOAT/PULLEYTYPE)
- I) LOCALTEMPERATUREINDICATORSINCLUDINGTESTPROCEDURE
- J) RESISTANCE THERMOMETER ELEMENT INCLUDING TEST PROCEDURE
- K) THERMOCOUPLEELEMENTANDCONNECTINGCABLE
- L) THERMOCOUPLEANDRESISTANCETHERMOMETERCONVERTOR/ TRANSMITTERINCLUDINGTESTPROCEDURES.
- M) TEMPERATURE SWITCH/THERMOSTAT INCLUDING TESTPROCEDURES
- N) COLDJUNCTIONBOXES
- O) ZENERBARRIER
- P) O2 ANALYSER
- Q) O2INHYDROGENINCLUDINGTESTPROCEDURES
- R) PRESSUREANDVACUUMGAUGE
- S) PRESSUREANDVACUUMSWITCHINCLUDINGTESTPROCEDURE
- T) DIFFERENTIAL PRESSURETRANSMITTERINCLUDINGTESTPROCEDURE
- U) DIFFERENTIALPRESSURESWITCHINCLUDINGTESTPROCEDURE.
- V) FLOWINDICATOR(VARIABLEAREA)
- W) ORIFICEPLATE
- X) TURBINEFLOWTRANSMITTER
- i) FLOWSWITCH
- ii) WEIR
- iii) NOZZLE
- iv) FLOW INDICATOR (PNEUMATIC INPUT) INCLUDING TEST PROCEDURE
- v) FLOWINTEGRATOR(PNEUMATICINPUT) INCLUDING TESTPROCEDURE
- vi) FLOWINDICATOR(FLOATOPERATED)INCLUDING TESTPROCEDURE
- vii) VENTURI(FLUID)
- viii) FLOWSWITCH(MAGNETICTYPE)
- ix) AVERAGINGINLET
- x) LIMITSWITCHES
- Y) TURBINESUPERVISORYMEASURINGSYSTEM
- Z) POSITIONMEASUREMENTANDINDICATIONINCLUDING TESTPROCEDURES
- AA) TACHOMETER
- BB VIBRATIONMEASUREMENT
- CC) DIGITALINDICATOR
- DD) MOVINGCOILINDICATORINCLUDINGTESTPROCEDURE
- EE) RECORDERINCLUDINGTESTPROCEDURE
- FF) FLAMESCANNER



- GG) ELECTRICALAUTOMANUALCONTROLSTATION
- HH) PUSHBUTTONMODULE
- II) ALARMANNUNCIATOREQUIPMENTINCLUDINGTESTPRO
- JJ) TESTPROCEDURE FORELECTRONICMODULESOFDDCMIS
- KK) THERMOCONTROLVALVE
- LL) TESTPROCEDUREFORADJUSTMENTOFMODULATING CONTROLLER-PIDTERMS
- MM) TESTPROCEDUREINDICATING CONTROLLER-ELECTRICALINPUT
ANDPNEUMATICOUTPUT

Note: The items which are not part of this specification may be considered as not applicable.

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ANNEXURE-II

BRIEF WRITE UP ON THE CONTENTS OF TESTING
SCHEDULE / COMMISSIONING SCHEDULE

Testing Schedules should be designed to ensure that the plant area, equipment or apparatus are tested and commissioned and will operate as per the UPRVUNL's specifications and good engineering practices.

Testing Schedule/Commissioning Schedule is required to be of a standard format in order to maintain consistency of presentation, content and reporting.

Testing Schedule/Commissioning Schedules should contain the following sections to make the document self-contained:

1. Plant Details/Design data
2. Testing Objective/Proposals
3. State of the Plant
 - a) Erection Status with respect to Mech Elect and C&I
 - b) Availability of the services required
 - c) Safety requirements as per Manufacturer's
4. Test method including completion/acceptance criteria
5. Results
6. Appendix
 - a) Testing Programme
 - b) Mech/Elect/C&I-Plant item completing list
 - c) List of Drawing/documents required for carrying out the testing.

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ANNEXURE - III

SAFETY PLAN

1. Safety Policy of the Contractor to be enclosed
2. When was the Safety Policy last reviewed
3. Details of implementation procedure / methods to implement Safety Policy / Safety Rules
4. Name, Qualification, experience of Safety Officer
5. Review of Accidents Analysis Method, Methods to ensure Safety and Health
6. Unit executive responsible to ensure Safety at various levels in work area
7. List of employees trained in safety employed before execution of the job. Give the detail of training
8. Safety Training Targets, Schedules, methods adopting to provide safety training to all employees
9. Detail of checklist for different jobs/work and responsible persons to ensure compliance (copy of checklist to be enclosed)
10. Regular Safety Inspection Methods and Periodicity and list of members to be enclosed
11. Risk Assessment, Safety Audit by Professional Agencies, Periodicity
12. Implementation of Recommendations of Audit/Inspections. Procedures for implementation and follow up
13. Provision for treatment of injured persons at work site
14. Review of overall safety by top Management and Periodicity
15. System for Implementation of Statutory legislations
16. Issue of PPEs to employees, Periodicity / stock on hand etc

Signature
Head of the Organisation
with date & stamp

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CHAPTER 10 : STORAGE OF EQUIPMENT / GOODS AT SITE

1.0 SCOPE

1.1 This specification details the general guidelines for storage of mechanical and electrical equipment at site from the date equipment are taken over by the CONTRACTOR until the same are erected and handed over to the OWNER.

1.2 The equipment covered under this specification shall be stored in the type of storage as recommended by the MANUFACTURER/OWNER/CONSULTANT.

2.0 CONSTRUCTION OF STORES

2.1 Normally, the OWNER makes available the space for the CONTRACTOR to construct the necessary stores as specified.

2.2 To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise wasteful handling during retrieval of items required for erection.

2.3 The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. The CONTRACTOR shall check the satisfactoriness of these facilities prior to monsoon.

2.4 The stores sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.

2.5 In case of storage of certain equipment / materials, it may be necessary to maintain specified temperature ranges. In such cases, it is the responsibility of the CONTRACTOR to provide adequate heating / air conditioning facilities on round the clock basis. The CONTRACTOR shall check that space heaters, heating bulbs and air conditioners are kept energised continuously as applicable. In the event there is a prolonged failure of electric power, rendering such air-conditioners/space heaters inoperative, the CONTRACTOR shall make alternative arrangements to ensure that items under storage do not suffer any damage / deterioration on this account.

2.6 Adequate lighting facility shall be provided by the CONTRACTOR in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials entrusted to him by the OWNER. The CONTRACTOR shall carry out regular inventory of materials received, issued and erected and notify the OWNER of any loss when noticed.

2.7 The CONTRACTOR shall provide adequate number of competent stores personnel including store-keepers, clerical staff, inspection engineers, watchmen and security staff to efficiently store and maintain the equipment / material entrusted to him.

2.8 Where necessary, the CONTRACTOR shall provide necessary space heating and other protective care to equipment in case it will take a long time to haul them

to the stores. Any equipment left in the open under such conditions shall be, if required, covered with tarpaulin.

3.0 MAINTENANCE DURING STORAGE

3.1 Where unloading from the carriers and transport to warehouses is excluded from the CONTRACTOR'S scope .The CONTRACTOR shall take over the materials from the OWNER'S storage area / sheds.

3.2 Where materials is unloaded by the OWNER before the CONTRACTOR arrives at site or even when the CONTRACTOR is already at site, the OWNER can hand over the material to the CONTRACTOR and thereupon it will be the responsibility of the CONTRACTOR to store and maintain these material in a proper and approved manner.

3.3 While taking over the materials, the CONTRACTOR shall carry out inventory and inspection of the same and submit a report of his observations to the OWNER. After taking over of the equipment / materials, the CONTRACTOR is solely responsible for the same until handing over to the OWNER the erected plant and surplus materials, if any. The CONTRACTOR is responsible for maintenance of the equipment / materials in storage, during erection and until commissioning including protection of the same against theft, elements of nature and corrosion damages. In case commissioning of the equipment is delayed, the CONTRACTOR shall be responsible for maintenance of the erected plant and equipment as directed by OWNER / CONSULTANT.

3.4 The CONTRACTOR shall repack the equipment after inspection and store the same in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks, preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks.

3.5 The CONTRACTOR shall carry out frequent inspection of materials stored and also extend necessary facilities to the OWNER / CONSULTANT to carry out such inspection, when considered necessary. The CONTRACTOR shall implement the suggestions of the OWNER/CONSULTANT in this connection.

3.6 At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground by providing good wooden sleepers.

3.7 Welded and cast units shall be stored in such manner that there is no danger of distortion.

3.8 All special measures to prevent corrosion shall be taken by the CONTRACTOR.

3.8.1 Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The CONTRACTOR shall inspect the materials and in case of signs of wear or damages to protective coating, that portion shall be cleaned with carbon tetra chloride or any other approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.

3.9 While handling the equipment, no dragging on the ground is permitted. The CONTRACTOR shall submit his scheme for handling major pieces of equipment



for approval by the OWNER / CONSULTANT prior to actual handling of the same. In cases where a scheme is recommended by the OWNER / MANUFACTURER, it shall be strictly adhered to.

- 3.10 The CONTRACTOR shall periodically inspect materials with specific reference to
- 3.10.1 Ingress of moisture and corrosion damages.
- 3.10.2 Damage to protective coating.
- 3.10.3 Open ends in pipes, vessels and equipment. In case any open ends are noticed, the CONTRACTOR shall get them capped.
- 3.10.4 Insulation of electrical equipment. Regular insulation checks are essential and these values shall be properly logged.
- 3.10.5 Any damages to equipment / materials.
- a) In case of any damages, these shall be promptly notified to the OWNER. In all cases, the repairs / rectification shall be carried out strictly as directed by the OWNER / CONSULTANT.
 - b) If such repairs / rectification is necessitated due to causes attributable to the CONTRACTOR, such repairs / rectification shall be carried out at no extra cost to the OWNER. In other cases, compensation for such repair / rectification works will be as mutually agreed to.
 - c) In case such damages are attributable to the CONTRACTOR and if, in the opinion of the OWNER/ CONSULTANT, the CONTRACTOR is not competent to carry out necessary repairs / rectification, the OWNER shall get this done by any other agency and recover the expenditure incurred by him from the CONTRACTOR.

4.0 MODES OF STORAGE

Given below are the general guidelines for storage of various equipments under the broad storage classifications. Wherever the specific recommendations of the MANUFACTURER/OWNER/CONSULTANT are at variance with what is indicated below, the former shall prevail.

4.1 Special Storage – Air Conditioned

The following materials are normally stored in air conditioned storage.

4.1.1 Welding Electrodes

These deteriorate under adverse conditions of storage and are preferably stored in air conditioned storage. As an alternative, if approved, these can also be stored in hot boxes / ovens.

It is essential to regularly inspect the conditions of electrodes and ensure that temperature is maintained within specified range at all times.

4.1.2 Ball, needle and roller bearings: These shall be stored in their original packing.

- 4.1.3 Photographic materials and films: These shall be stored in their original moisture vapor proof packages.
- 4.1.4 Rubber Goods: These shall be protected against sunlight and artificial light as well as high humidity conditions.
- 4.1.5 Hydraulic / Electronic equipment / instruments and components - These shall be stored in sealed packages.
- 4.2 Closed storage
- The following materials are normally stored in closed storage.
- 4.2.1 Cement bags.
- 4.2.2 All small parts / components liable to be misplaced / lost. These shall include the following:
- a) Small structural cleats, bolts, nuts, washers, etc. High tensile bolts and nuts shall be stored in separate sealed boxes with proper identification to avoid mix up with other items
 - b) Pipe hangers, spring hangers, etc. The identification numbers on spring hangers shall be carefully preserved during storage
 - c) Stainless steel and copper tubes, pipe fittings, etc.
 - d) Electrical clamps, cable boxes, cable glands, ferrules, fuses, control cables, copper cables and grounding strips, push button switches, etc.
 - e) Pilot valves, pull rods, keys, control valves. These shall be greased, wrapped in paraffin paper and stored in packing boxes
 - f) Turbine governing system components
- 4.2.3 All loose turbo generator parts, turbine sole plates and packing plates, bolts and studs.
- 4.2.4 Generator and turbine rotors, stators, bearings, liners, control gears, etc.
- 4.2.5 Boiler fine fittings, soot blowers, mill and fan bearings, hangers and couplings.
- 4.2.6 Electrostatic precipitator electrodes, connecting links, etc.
- 4.2.7 Drive units of regenerative air heaters, fans, mills, etc., motors, pumps, blowers, ejectors and compressors, including those supplied disassembled.
- 4.2.8 Oil and hydrogen coolers.
- 4.2.9 Seal oil and gas control system equipment.
- 4.2.10 All indoor switch gear equipments.
- 4.2.11 Bus ducts, exciters, excitation system equipment, voltage regulators, circuit breakers, potential and current transformers, lightning arrestors, bushings, storage batteries and cells.

- 4.2.12 All instrument parts such as measuring instruments, controllers and regulators, interlock system, control drive units, gauges, instrument valves, thermocouples and leads.
- 4.2.13 Thermal and insulation materials. Mineral wool, glass wool, castable refractories, fire bricks, asbestos, etc.
- 4.2.14 DM plant chemicals and resins.
- 4.2.15 Synthetic paints. Normally in separate stores.
- 4.3 Semi-Closed Storage
- The following materials are normally stored in semi-closed storage.
- 4.3.1 Condenser tubes stored in boxes.
- 4.3.2 Dust collector elements in boxes.
- 4.3.3 Coal mill liners, shell, coal feeders and gates, separator assembly.
- 4.3.4 Boiler dampers, manhole doors, mountings, casing frames, buck stays, Air pre-heater frames tubes, baskets. Burner panels and burners, Electrostatic precipitator shell, discharge and collecting plates.
- 4.3.5 Fan impellers, large assembled pumps, compressors, crushers, pulleys and idlers, wagon tippler drive assemblies and bearings, outdoor motors, etc..
- 4.3.6 Large C. I. Valves, butterfly valves, stop and control valves, expansion joints.
- 4.3.7 Outdoor switch gears and panels, small transformers, cable tray parts, etc.
- 4.3.8 Crane rope drums, hoists, trolleys. Wire ropes in drums covered with tarpaulin.
- 4.3.9 Bearing stands
- 4.3.10 Conveyor belts
- 4.4 Open Storage
- The following materials are normally stored in open storage.
- 4.4.1 Fabricated and un-fabricated structural steel members, Chimney steel, stairways and hand rails. Gallery steel Crane bridges and steel members, Reinforcement steel.
- 4.4.2 Coarse aggregates and sand.
- 4.4.3 Un-fabricated pipes and fabricated pipe assemblies, Concrete and hume pipes. Large diameter conduits / pipes in boxes, Ash disposal pipes.
- 4.4.4 Boiler, drum, tubes, tube panels and headers.
- 4.4.5 Mill drums, bunker plates, etc.
- 4.4.6 Condenser shell parts, water boxes, etc.

- 4.4.7 Air pre-heater tube plates.
- 4.4.8 De-aerators, feed water heaters, etc.
- 4.4.9 Conveyor steel, and wagon tippler parts except drive units
- 4.4.10 Pressure vessels, reaction towers and columns, Fabricated vessels and tanks shall have their openings firmly blanked.
- 4.4.11 Flocculator Bridge, D.M. plant filters, vessels, etc.
- 4.4.12 Cable drums
- 4.4.13 Large power transformers
- 5.0 SPECIFIC GUIDELINES FOR STORAGE
- Given below are the guidelines for certain other major equipment / materials. These are broad guidelines only and storage shall be strictly as directed by the Manufacturer / OWNER / CONSULTANT.
- 5.1 Condenser
- Condenser shells shall be stored on sleepers in open storage. The materials shall be kept resting in such a manner that there is no distortion to the assemblies. The bracings provided at the factory shall not be disturbed. Handling shall be strictly as per the recommendations of the Manufacturer. The tube sheets shall be protected against corrosion and tube holes against scratches. The condenser tubes shall be inspected on receipt and stored in boxes in which they are reviewed.
- 5.2 Deaerator
- The deaerator shall be drained of water and stored dry. The nozzles shall be sealed / capped. If trays are delivered separately, these shall be stored on racks in closed storage.
- 5.3 Feed Water Heaters, Heat Exchangers, Vessels and Bearings
- 5.3.1 These equipment shall be drained of water and stored dry, with openings and flanges sealed / capped.
- 5.3.2 The hooks, eye bolts, etc., provided shall be used for handling these equipment.
- 5.3.3 All machined surfaces shall be coated with approved protective coating at regular intervals.
- 5.3.4 Heat exchangers shall be stored in horizontal position.
- 5.4 Rotating Equipment such as Pumps and Compressors
- 5.4.1 These are normally stored in assembled condition in closed / semi-closed storage. When stored in semi-closed storage, they shall be covered with tarpaulin and bed plates shall rest fully on sleepers.

- 5.4.2 The CONTRACTOR is responsible for proper lubrication of these equipment as directed.
- 5.4.3 The gear boxes and oil sumps shall be kept filled with recommended lubricating gear oil. The couplings and bearings shall be covered with approved grease and nozzle flanges screwed with caps or suitably plugged.
- 5.4.4 Pumps, if delivered in dis-assembled condition, shall be stored with the parts properly greased and wrapped in paraffin paper. Smaller parts are to be stored on racks whereas larger parts on sleepers in closed storage. Occasional flushing with hot lubricating oil may have to be carried out, if so directed; in the cases of equipment such as boiler feed pump.
- 5.4.5 The shafts of rotating equipment shall be turned by 90° every week to avoid rotor journals from rusting and to ensure that shaft is free to rotate.
- 5.4.6 The CONTRACTOR shall maintain record of lubrication with details of lubricants used as well as protective measures carried out.
- 5.5 Piping and Valves
- 5.5.1 All pipes shall be stored on sleeper beds with open ends securely capped. The beveled ends shall be protected with a coating of approved grease. If so directed, inside surfaces of piping shall be coated with approved protective solution.
- 5.5.2 Pipes shall be neatly arranged and stacked for easy identification and retrieval.
- 5.5.3 Pipes shall be blown with air prior to installation and it shall be ensured that there is no obstruction.
- 5.5.4 Valves shall be stored with the discs screwed down on the seat so that packing surfaces are not exposed to dust. All machined surfaces shall be covered with grease. Preservation of identification tags is essential to avoid installation in a wrong service.
- 5.6 Switch gear & Control Panels
- 5.6.1 Depending on whether these are of indoor or outdoor design, these shall be stored in closed / semi-closed storage.
- 5.6.2 The spaced heaters, where provided, shall be kept connected with power supply irrespective of mode of storage where space heaters are not provided, use of adequate number of heating bulbs is recommended.
- 5.6.3 Insulation resistance shall be measured at regular intervals and megger values properly logged.
- 5.7 Transformers
- 5.7.1 It is advisable to assemble and set the transformer filled with oil in its permanent location soon after receipt even if it is not likely to be put in service for a while. In case of gas filled transformers, a positive pressure should be maintained during storage as recommended by the Manufacturer. If transformer is to be stored partially or fully dis-assembled, it shall be protected against moisture ingress / absorption by keeping them immersed in

transformer oil or as recommended by the MANUFACTURE / OWNER / CONSULTANT.

- 5.7.2 Prior to charging any transformer, it is essential to check the satisfactoriness of insulation values and di-electric strength of oil.

5.8 Cells, Accumulators, Batteries

These shall be stored in a dry and well ventilated place and protected from extreme cold. Internal parts of large cells are loose and the cells should be handled with care to avoid displacement of internals. Saw dust shall never be used for packing batteries as it is hygroscopic.

5.9 Cables

Cable drums if stored indoors shall be in dry, ventilated stores. Cables are normally supplied with ends sealed. When a length is cut, the end should be resealed. The drums shall be stored with adequate spacing between them for better air circulation.

5.10 Motors

Besides general procedures such as regular inspection and recording of insulation resistances, in the case of LT motors, if so recommended, low voltage current flow through the windings may be maintained during storage.

5.11 Instruments

- 5.11.1 These are stored on racks in closed storage and in air conditioned storage if so recommended. These shall be stored in their packages in dry condition and shall be handled with extreme care.

- 5.11.2 Instrument flanges and nozzles, if directed, shall be coated with technical Vaseline.

- 5.11.3 In the case of fragile instruments, the storage shall be in a separate zone away from where heavy materials are stored to minimise danger of damage.

5.12 STEEL

5.12.1 Reinforcement steel:

Reinforcement steel shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If stored for long periods, these may be coated with cement wash before stacking to prevent loose scales and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.12.2 Structural steel:

Structural steel could safely be stored in open storage but with sufficient space in between for handling and crane movement. All steel shall be stored 200 mm above ground on suitable packing to avoid damage. It should be stored according to sizes and sections preferably in the order required for erection. The area for open storage should be properly graded to avoid water logging in the storage area. Steel shall not be stored in the vicinity of areas where excavation or grading will be done. Scratched or abraded steel shall be given a

coat of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable coating.

5.13 Cement

5.13.1 Cement shall be stored in bags in a separate shed away from where mechanical and electrical equipment are stored to minimise the possibility of cement dust settling on the equipment.

5.13.2 The storage shed where cement is stored shall be absolutely water tight. The flooring shall be a 15 mm thick concrete slab laid on a dry course soling or as recommended. The ground shall be drained away from the shed to prevent accumulation of water in its vicinity.

5.13.3 The bags shall be neatly stacked with adequate passage in between for easy retrieval. The cement shall be issued on 'First-In-First-Out' basis.

5.13.4 In case different grades of cement are stored in the same shed, each grade shall be stacked separately to avoid mix up and clear indication boards shall be provided to identify different grades.

5.14 Synthetic Paints

These have limited life and as a safeguard against possible deterioration, the drums shall be inverted at regular intervals as specified to minimise risk of hard settling of pigments.

5.15 Slings & Wire Ropes

All slings and wire ropes shall be coated with approved grease and hung from racks in rolled condition.

6.0 DOCUMENTATION

The CONTRACTOR'S store-keeping function will include maintaining various records as required by the OWNER / CONSULTANT. These records shall include but not be limited to:

6.1 Supplier wise record of equipment / material received stored and issued for erection as well as stock position.

6.2 Record of inspection and repairs carried out, protective measures and lubrication of equipment in storage as well as erected until the same are taken over by the OWNER.



TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN

SPECIFICATION No: PE-TS-426-501-A101

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

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MAKES OF SUB-VENDOR ITEMS

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	STEEL	SAIL		
		TISCO		
		JINDAL		
		ESSAR		
2.	HOOKS	STEEL FORGING & ENGG. CO.,	KOLKATA	
		SIMRITI FORGING		
		KARACHIWALA		UP TO 25T CAPACITY
3.	GEAR COUPLINGS	ALLIANCE		
		FLEX-TRANS (formerly known as HICLIFF)		
		SAHARA		
		NUTECH		
		OEM		
4.	WIRE ROPE	USHA MARTIN		
		FORT WILLIAMS		
		BHARAT WIRE ROPES		
5.	BEARINGS	SKF		
		FAG		
		TATA		
		NBC		
6.	MOTORS	SIEMENS		
		NGEF (up to 15KW)		
		CROMPTON		
		KIRLOSKAR		
		BHARAT BIJLI		
		MARATHON		
		ABB		
7.	BRAKES	ELECTROMAG		
		SPEED-O- CONTROL		
		BCH		FOR DCEM BRAKES ONLY
		KAKKU		
		PATHE		
8.	CONTACTOR	SIEMENS		
		L&T		
		SCHNEIDER (Earlier TELE MECHANIQUE)		

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SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		BCH		
9.	OVER LOAD RELAYS	SIEMENS		
		L&T		
		ABB		
		SCHNEIDER (Earlier TELE MACHANIQUE)		
10.	HRC FUSES	SIEMENS		
		L&T		
		ENGLISH ELECTRIC		
		GE POWER		
		EATON (BUSSMANN)		
		ABB		
11.	ISOLATING SWITCH	SIEMENS		
		L&T		
		CONTROL & SWITCH GEAR		
		ABB		
12.	SWITCH FUSE UNITS	SIEMENS		
		L&T		
		CONTROL & SWITCH GEAR	-	
		ABB		
13.	TIME DELAY RELAYS	SIEMENS		
		L&T		
		ABB		
		BCH		
		SCHNEIDER (Earlier TELE MACHANIQUE)		
14.	TRANSFORMERS	INDCOIL		
		LOGICSTAT		
		KAPPA		
		AUTOMATIC ELECTRIC		
		PRECISE ELECTRICALS		
		SILKAAN ELECTRIC MFG. CO. LTD.		
		SOUTHERN ELECTRIC		
		NEC		
15.	BULB & FLOURESCENT TUBES/FITTINGS	PHILIPS		
		BAJAJ		
		CROMPTON		
16.	CABLE LUGS (HEAVY DUTY)	DOWELLS		
		UML ENGINEERS	KOLKATA	
		JAINSON		
17.	HOOTERS	BEACON		

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

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		CORDS CABLE INDUSTRIES LTD	NEW DELHI	
		CRYSTAL CABLE INDUSTRIES LTD	KOLKATA	
		DELTON CABLES LTD	NEW DELHI	
		DIAMOND POWER 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	
		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	

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

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		LTD		
		KEC INTERNATIONAL LIMITED	MUMBAI	
		PARAMOUNT COMMUNICATIONS LTD	NEW DELHI	
		POLYCAB WIRES PVT. LTD	MUMBAI	
		RADIANT CORPORATION PRIVATE LIMITED	HYDERABAD	
		RAVIN CABLES LIMITED	MUMBAI	
		SUYOG ELECTRICALS LTD	VADODARA	
		SRIRAM CABLES PVT. LTD	NEW DELHI	
		TORRENT CABLES LTD	AHMEDABAD	
		UNIVERSAL CABLES LTD	SATNA	
24.	CABLE GLAND	COMMET		
		SUNIL&CO		
		ARUP ENGINEERING		
		JAINSON		
		DOWELL		
25.	PUSH BUTTONS	SIEMENS		
		L&T		
		BCH		
		SCHNEIDER		
26.	LIMIT SWITCHES	SPEED-O-CONTROL		
		ELECTROMAG		
27.	MASTER CONTROLLER	SPEED-O-CONTROL		
		ELECTROMAG		
28.	SAFETY SWITCHES	ALSTOM		
		L&T		
		SIEMENS		
29.	PENDENT PUSH BUTTON STATION	OEM		
30.	INDICATING LAMPS	TECKNIC		
		BCH		
		SIEMENS		
		STANDARD		
31.	MCB	MDS		
		INDO COPP		
		STANDARD		
		SIEMENS		

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

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		BONGFILIOLI*		
41.	RAIL	JSPL		
		SAIL		

NOTE:

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

PART OF SPECIFICATION PE-TS-426-501-A101



**TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN**

SPECIFICATION No: PE-TS-426-501-A101

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

SECTION-I

SUB-SECTION-IA

REV. 00

DATE: MAY 2019

**ANNEXURE-II
MANDATORY SPARES**

	EOT CRANE	Qty	Total qty
1	Carbon brushes for each Motor	3	3 Sets
2	Brush holders for each Motor	1	1 Set
3	Bearing for Each Motor	1	1 Set
4	One set of bearings for each reduction gear unit	1	1 Set
5	Bearings each for across travel & long travel wheels	1	1 Set
6	Linings for each of the brake shoes complete with rivets	2	2 Sets
7	Contactors of each type & rating	2	2 Nos. each
8	Timers of each type	2	2 Nos. each
9	Limit switches & switches of each type	1	1 Set each
10	Sockets of each type	1	1 Set each
11	Double roller collectors	3	3 Sets
12	Porcelain insulators of each type	2	2 Sets each
13	Contacts for Master Controllers	2	2 Sets
14	Brake springs for main & auxillary hoist brakes	3	3 Sets
15	Coils for all Contactors	1	1 Set each
16	415V MOTOR		
a	Terminal plates	1	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW
b	Heaters	2	2 sets
c	Greasing arrangements	4	4 sets each type of motor
d	Dust seals and gaskets for each type of motors	3	3 sets each type of motor
e	Motor of each type and rating	1	10% of the installed quantity or minimum 1 number whichever be higher
f	Bearings (DE and NDE) for each type and rating of motor	4	4 sets
g	Stator winding coils for all type of LT motors	1	1 set
17	1.1 KV Grade power cables for each type and size.	1	10% of installed quantity
18	1.1 KV Grade control cables for each type and size.	1	10% of installed quantity
19	Control desk and Control Panels:-	-	-
a	LEDs for indicating lights shall be furnished.	1	100%
b	control circuit fuses	1	One hundred percent spare replacement of each current rating required
c	MCB/MCCB	1	Ten percent spare replacement of each current rating required
d	Blank Mosaic Grid Tiles.	1	Ten (10) percent or 20 nos (whichever is more)
e	Push buttons, ILPBs.(complete with contact elements)	1	Ten (10) percent or 2 nos (whichever is more) of each type and color.
f	Cooling Fans	1	20% or 2 nos. (whichever is more) of each type, model and rating.(IF APPLICABLE)
g	Electric meter.	1	Ten (10) percent or 2 nos (whichever is more) of each type
h	Power supply modules.	1	Ten (10) percent or 2 nos (whichever is more) of each type

PART OF SPECIFICATION PE-TS-426-501-A101



**TECHNICAL SPECIFICATION
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NOTES

- 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. One (1) set means 100% requirement for one crane.
- 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 is any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.
- 5) Mandatory spares shall not be dispatched before dispatch of corresponding main equipment. The spares shall be treated and packed for a long storage under the climatic condition prevailing at site.
- 6) Interchangeability and Packings:
All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares should include all mounted accessories like components, boards, add on items, fitting, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require any additional item. The vendors must conform the pair to pair compatibility of each electrical spares modules with the modules should be supplied in the original package. All electronic modules should be pre-set and/or preprogrammed for ready use at site. Alternatively, suitable instruction sheet indicating the details of required PCB jumper position, BCD which is setting, EPROM/PROM listing etc. should be packed along with each module. Also a caution mark sign should be put on all such module which needs pre-setting/pre-programming before putting them in to service. The spare shall be treated and properly packed for long term storage.
- 7) Identification:
Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.
- 8) Mandatory spares listed above is bare minimum requirement. In case any additional mandatory spares requirement is covered elsewhere in the tender specification, same shall be deemed to have been covered in bidder's scope of supply.

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TECHNICAL SPECIFICATION
FOR
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SPECIFICATION No: PE-TS-426-501-A101

**PACKAGE: DOUBLE GIRDER EOT CRANE
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SECTION-I

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DATE: MAY 2019

ANNEXURE-III
TOOLS & TACKLES

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

S-No.	Description	Qty.
1	Complete set of ring spanners (Indicate the sizes offered)	1 Set
2	Complete set of screwdrivers (Min. 6 Nos., Indicate the sizes)	1 Set
3.	Adjustable Spanner	1 No.
4.	Insulated plier	1 No.
5	Wrench spanner	1 No.
6.	Grease Gun	1 No.
7.	Oil Gun.	1 No.
8.	Hand Lamp.	1 No.
9	Line tester	1 No.

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



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FOR
1X660 MW PANKI EXTN

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

SECTION-I

SUB-SECTION-IA

REV. 00

DATE: MAY 2019

ANNEXURE-IV
PAINTING SPECIFICATION

PART OF SPECIFICATION PE-TS-426-501-A101

SIS: 55900 : Swedish standard for blasting

In the event of conflict between the Codes and Standards referred to in the specification and the requirement of this specification, the latter shall govern. Statutory and Local regulations shall be strictly followed in selection and application of paint.

3.0 GENERAL

3.1 This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).

3.2 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

3.3 The paint to be applied shall be approved by Customer / Engineer.

3.4 All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.

3.5 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:

1. Surface preparations
2. Film thickness (min and max)
3. Min and max recoating intervals at relevant temperatures
4. Mixing ratio, thinner details and coating repair systems

3.6 The sample for testing the paint being used may be taken by the customer at any time.

3.7 In general Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish in accordance with the requirements of this specification.

3.8 For equipment that has received shop prime coat, touch-up prime coat and additional coats shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.

3.9 Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter. Damage to other surfaces or equipment shall be repaired by the vendor.

3.10 The Contractor shall submit the following for review and approval by the Customer:

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1. Manufacturer's recommended paint scheme for the project
2. Latest published product & instructions for application data,
3. Procedures for surface preparation and application.
4. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
5. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

- 3.11 The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.
- 3.12 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.
- 3.13 Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.
- 3.14 It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.
- 4.0 PREPARATION OF SURFACES
- 4.1 All surfaces to be painted shall be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust, weld spatters, sharp edges and any other foreign matter. Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.
- 4.2 Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.
- 4.3 The blast cleaned surface shall be checked for signs of salt contamination as per ISO 8502-6 & 9. The maximum allowable level of contamination shall be 20 mg/m². Surfaces that do not meet these criteria shall be reprocessed.

Mechanical Cleaning:

Manual/power tool cleaning shall be done as per grade St-2 or St-3, of ISO 8504-3. This method to be used for repair painting or on already painted



surface and in case of usage on new construction painting prior approval may be obtained from purchaser/engineer.

	Condition of surface	ISO 8504-3	SIS 055900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted and pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted and pitted	D St3	D St3	SP3

- i) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.
- ii) Grade St-3: very thorough scraping and wire brushing, machine brushing, grinding etc. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.

Blast cleaning:

Compressors: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110deg C. The blasting activity shall be performed at ambient temperatures above 5°C and relative humidity less than 85%. Steel temperature shall be 3°C above dew point. Necessary safety precautions for equipment and operator shall be adhered to.

Abrasives: Abrasives used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives may be chilled iron grit or shot steel and malleable iron grit and shots non metallic abrasive (aluminium oxide, copper slag, garnet etc.).

Removal of mill scale and rust using abrasives such as grit or shot under high pressure. The grade of blasting performed in line with the approved painting scheme.

Surfaces to be coated shall be free of all grease, oil, loose rust, and loose mill scale. Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Coating Schedule. Oil and grease shall be removed by solvent cleaning method as outlined in SSPC - SP - 1 prior to blasting.

The quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the surface profile depth and cleanliness. Abrasives shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertaining to the work.

Profile measurements for abrasive blast cleaned surface shall be made with a Profile comparator and permanent record shall be maintained with Testex Press-O-Film.

Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and

commencement of painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

After blasting cleaning, depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 mm may be used.

The grades of surface finish:

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Paint Application

General:

Paints and other coating materials shall be applied in accordance with the paint manufacturer's instructions. The surface preparation and painting system shall be as described in ANNEXURE with the following exceptions:

- Nameplates, code stampings and push buttons
- Concrete brickwork, tile, and glass unless specified by the Purchaser / Engineer
- Non-ferrous materials
- Austenitic stainless steel
- Plastic and / or plastic coated materials
- Insulated surface of equipment and pipes except colour coating wherever required
- Any surface specified by the Purchaser / Engineer not to be painted.

Paint Application Requirements

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mix ratio, the method of application, and the use of thinners and over coating times.

Paint application shall be by brush, roller or spray gun. Local regulations regarding spray and roller coating shall be observed. A smooth uniform film shall be applied to the surfaces to be coated.

Painting shall be performed when the temperature of the surface is greater than 3°C above the dew point of the surrounding air and relative humidity of the air is less than 85% unless local conditions dictate otherwise and the Customer is in agreement. Guidance on the estimation of the probability of condensation can be found in ISO 8502-4. The measurement of these conditions is the responsibility of the Vendor.

In addition, paints shall not be applied under the following conditions:

- When the surface temperature is greater than 60 °C (unless a higher temperature is agreed by the paint manufacturer)
- When the air temperature is less than approximately 5°C, (depending on local conditions)

- When there is the likelihood of an unfavourable change in weather conditions within two hours after painting
- When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.
- When the available light is less than 500 lux.

Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld areas shall be taped/one coat of weldable primer for distance of 50 mm either side of the weld line.

When zinc rich primers are used, care shall be taken to mask to avoid any possibility of over spraying onto duplex, austenitic stainless steels; nickel alloys or 9% nickel steel components.

Two pack coatings like Air drying epoxy, Polyurethane coatings etc shall be mixed in the ratio recommended by manufacturer to ensure proper and complete curing of the coatings. The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing / agitation and not the reverse. Power agitation is preferred over hand mixing.

Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed. Excess thinner is not recommended, as increase in volume, leads to lower DFT, sagging, longer curing time, etc.

Coating containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by continuous use of a mechanical agitator whilst being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

Transport and erection of painted structures shall be carried out only after the drying time specified by the paint manufacturer has elapsed. Handling & packing of painted material shall be appropriate to avoid damage to painting, such as the use of non-metallic slings, etc for handling and by minimising handling after painting. All steel equipment shall be provided with priming or coating system to protect the steel surface during transport, storage, installation and construction.

Spray Application

Airless or pneumatic spray applications are preferred methods of application. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90° to the surface being painted.

Approval of Purchaser / Engineer shall be obtained during spray painting which may cause interference to other works. If spray painting is to be carried out, the following shall be taken into account:

The correct spray tips, air pressures, etc, as recommended by the equipment supplier, shall be used.

Conventional air spray equipment is used, the correct combination of air volume, air pressure and fluid flow to give good atomisation to be ensured to

get a defect free painted surface. The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method as most paints have to be thinned to a suitable viscosity for satisfactory atomisation, and so lose their high build properties. Vendor shall follow manufacture's instruction.

Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied as paint in the tank can be prevented from settling, reduces application time and also enables the gun to be turned to any angle to coat objects effectively without spilling paint.

Airless spray is recommended as high build coatings can be applied without thinning, very rapid application is possible, giving an economic advantage, compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and less dust and fume hazards.

Each coat shall be applied uniformly and completely over the entire surface. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface re-sprayed.

Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

Brush application

Brush application may be used under the following circumstances:

- When areas cannot be properly coated by spraying for reasons such as material or environmental considerations
- For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application
- For "touch up" or repairs to localize damaged paint or areas of incorrectly applied paint
- Where the paint manufacturer considers the coating material suitable for brush application.

Brushes shall be of a style and quality that will permit the proper application of paint.

Brush applications should be done in two passes that are perpendicular to each other 'wet on wet' so that a smooth coat, as near uniform in thickness as possible, is obtained thereby avoiding running and droplets. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.

During the application of each coat, all areas such as corners, edges, welds, small brackets, bolts, nuts and interstices shall receive additional paint to ensure that these areas have at least the minimum specified dry film thickness and to ensure continuity of coating.

Roller application

Roller application shall only be used on relatively large surface areas and only if spraying is not an option. Roller application shall only be used if the first or priming coat of paint has been applied by brush. Roller application shall be in accordance with the paint Manufacturer's instructions.



Coating materials

The selected coating materials shall be suitable for the intended use and shall be selected after an evaluation of all relevant aspects such as

- Corrosion protective properties
- Requirements to health, safety and environment
- Properties related to application conditions, equipment and personnel
- Experience with the coating materials and coating system.

All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions. Performance standard as listed below shall be established by paint manufacturer the records shall be submitted for review.

- Adhesion test (pull off test)
- Flexibility test
- Salt spray test (min 1000 Hrs)
- Water absorption test
- UV resistance test (external coating)
- Cathodic disbonding test (internal coating)
- Abrasion test (internal coating)
- Impact resistance test
- Sea water immersion test (structures in tidal, splash zone and conveying sea water)

Each product shall have a batch number showing year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, State or Local regulatory bodies for the products. All vehicle components for use in the manufacture of paints and enamels shall meet the ASTM/ ISO Specification except as otherwise stated coating systems shall be selected as per corrosivity category listed in the table below. Coating systems are tabulated in ANNEXURE and shall be pre-qualified in accordance with specification. Coating systems/ alternative coating systems may be re-subjected to pre-qualification, at the discretion of OWNER/ ENGINEER. The specified coating systems, the number of coats and the coating film thicknesses given in Annexure are minimum requirements Top coat colors should be in accordance with Annexure.

Gratings and step threads

- i) Surface preparation

Gratings and step threads shall be cleaned by acid pickling as per SSPC-SP-08.

- ii) Hot dip galvanising

The hot dip galvanising shall be done as per IS 2629 .The average mass of coating shall be 610 gms/m².



iii) Post galvanising treatment

Immediately after galvanising, post treatment such as chromating shall be applied to retard white rust attack.

iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A 780.

CORROSIVITY OF ENVIRONMENTS

Corrosivity category		Mass loss per unit surface (per year of exposure)	
		Mass loss g/mm ²	Thickness loss μ m
C2	Low	>10 to 100	>1.30 to 25
C3	Medium	200-400 g/m ²	(25-50 μ m)
C4	High	400-650 g/m ²	(50-80 μ m)
C5	Very High Industrial & marine	650-1500g/m ²	(80-200 μ m)

Tests required for evaluation of acceptance of coating materials:

TABLE -1

PERFORMANCE TEST OF PAINT

SL. No.	Test	ASTM TEST METHOD
1.0	Abrasion Resistance: (topcoat only)	ASTM D4060
2.0	Adhesion:	ASTM D4541
3.0	Dry Heat Resistance:	ASTM D2485
4.0	Flexibility: (topcoat only)	ASTM D522, 180° bend
5.0	Pencil Hardness: (topcoat only)	ASTM D3363
6.0	Salt Fog Resistance:	ASTM B117, 1000 hours
7.0	Weather Resistance:	ASTMG23 Type D
8.0	Test	ASTM Test Method
9.0	Density	D 1475
10.0	Dipping properties	D 823
11.0	Drying time	D 1640
12.0	Flexibility	D 1737/D 522
13.0	Hardness	D 3363
14.0	Adhesion (pull off test)	D 4541
15.0	Abrasion resistance	D 968/D 4060
16.0	DFT/Coat	As per SSPC Guidelines
17.0	Storage Stability	D 1849
18.0	Resistance to	
	i) Humidity for 2000 hrs.	D 2247
	ii) Salt Spray for 2000 hrs.	B 117
	iii) Accelerated Weathering	D 822

INSPECTION:

Inspection will be performed by an inspector authorised by Purchaser / Engineer. Paint materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specification and shall be accompanied by manufacturer's test certificates.

The painting work shall be subjected to inspection by purchaser / engineer at all times. The vendor shall offer following stage of inspection:

- Surface preparation
- Primer application
- Subsequent coats
- Paint qualification test

Vendor shall provide the expert technical services of the paint manufactures as and when required by purchaser / engineer to ensure both the surface preparation and applications are carried out as per their recommendations. This service shall be provided without any obligation to purchaser.

The following coating inspection & test shall be carried out:

1. Ambient and steel temperature, relative humidity and dew point min twice in a shift.
2. Surface finish & profile check each component or once per 10 m2 after surface preparation.
3. Salt contamination test - Free from salt contamination.
4. Dry Film Thickness as per ISO 2808 No.6.
5. Holiday Test as per ASTM D 5162/ NACE RP 0188.
6. Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

6.0 SUGGESTED COLOUR CODES FOR PAINTING:

Sl. No.	Item / Service	Colour	IS-5	Colour (Band)	IS-5
1.0	Structures, platforms, ladders and handrails	Dark Admiralty Grey	632		
2.0	Boiler casing, ESP and ducting	Nut Brown	413		
3.0	Fans, pumps, motors,	Light Grey	631		
4.0	Tanks (without insulation and cladding)				
4.1	Outdoor	Aluminium			
4.2	Indoor	Light grey	631		
5.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631		
6.0	Switchgear	Light grey	631		
7.0	Control & relay panels	Light grey	631 78 of IS1650		
8.0	Turbine	Golden	356		



Sl. No.	Item / Service	Colour	IS-5	Colour (Band)	IS-5
		Yellow			
9.0	Generator & exciter	Light grey	631		
10.0	Transformers	Aluminium			
11.0	Machinery guards	Signal red	537		
12.0	Crane				
12.1	Crane structure	Golden Yellow	356		
12.2	Trolley and hook	Crimson	540		
13.0	Piping (without insulation and cladding)				
13.1	Water System				
13.1.1	Boiler feed	Sea green	217		
13.1.2	Condensate	Sea green	217	Light brown	410
13.1.3	Bearing cooling water	Sea green	217	French blue	166

Notes:

1. This colour code basically refers to IS: 2379 for piping with necessary modifications.
2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

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PAINTING SCHEME FOR C2 AMD C3 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat		Total DFT
			Paint	No. of coats	DFT μ	Paint	No. of coats	DFT μ	Paint	No. of coats	
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120°C	Sa 2 1/2	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	Poly urethane	2	260 μ
2.	Indoor structure	Sa 2 1/2	HB Zn Phosphate	2	80 μ	HB MIO epoxy	1	120 μ	--	--	260 μ
3.	Insulated parts exposed to temp >120°C	Sa 2 1/2	In organic Zn silicate	2	60 μ						60 μ
4.	Work shop	Sa 2 1/2	HB Zn Phosphate	2	80 μ	HB MIO epoxy	1	120 μ	--	--	260 μ
5.	Water Treatment Plant (external)	Sa 2 1/2	Zn rich epoxy	2	80 μ	HB MIO epoxy	2	200 μ	Aliphatic poly urethane	2	360 μ
6.	Coal Handling Plant	Sa 2 1/2	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	poly urethane	2	260 μ
7.	Fuel pipings	Sa 2	Ethy Zn silicate	1	40 μ				HR aluminium paint	2	80 μ
8.	Un insulated silencer, steel stacks >120°C	Sa 2 1/2	Ethy Zn Silicate	1	40 μ				HR silicone aluminium paint	2	80 μ
9.	Above ground piping	Sa 2 1/2	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	Poly urethane	2	260 μ
10.	Burried piping (External)	Sa 2 1/2	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre								4.0m m
11.	Burried piping (Internal)	Sa 2 1/2	Solid rigid poly urethane 500 μ								500 μ
12.	Storage tanks (external)	Sa 2 1/2	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	120 μ	Poly urethane	2	260 μ
13.	Storage tanks (internal)	Sa 2 1/2	3 coats of amine adducts								400 μ



1 x 660 MW - Panki Thermal Power Station

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DCPL

			Hard rubber lining min 4 mm thickness										4. mm
14.	DM water piping (internal)	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	150 μ	HB coal tar epoxy	1	150 μ	380μ	
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 μ	HB MIO epoxy	1	150 μ	HB coal tar epoxy	1	150 μ	380μ	
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	75 μ							75μ	
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	Polyamide cured epoxy coating	2	250 μ							250μ	
18.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 μ				Chlorinated rubber	2	80 μ	160μ	
19.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 μ				Chlorinated rubber	2	100 μ	180μ	
20.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising 80μ									80μ	

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance



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PAINTING SCHEME FOR C4 AMD C5 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120°C	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
3.	Insulated parts exposed to temp >120°C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Work shop	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
6.	Coal Handling Plant	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	2	200 µ	Poly urethane	2	60 µ	340µ
7.	Coal Fuel pipings	Sa 2	Ethy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
8.	Un insulated silencer, steel stacks >120°C	Sa 2 ½	Ethy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly urethane	2	60 µ	260µ
10.	Burried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel									4.0 mm
11.	Burried piping (internal)	Sa 2 ½	Solid rigid poly urethane 500 µ									500µ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	2	200 µ	Poly urethane	2	60 µ	340µ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4.0



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* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.



**TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN**

SPECIFICATION No: PE-TS-426-501-A101

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

SECTION-I

SUB-SECTION-IA

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**ANNEXURE-V
MAIN DRAWING LIST WITH SCHEDULE OF SUBMISSION**

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

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

S.N.	BHEL drawing No.	Title	Approval category	Schedule date of submission from date of LOI.
1	PE-V0-426-501-A101	Manufacturing Quality Plan with sub vendor list For D/G EOT CRANE UPTO 100T	A	2
2	PE-V0-426-501-A103	Data sheet of motors for D/G EOT CRANE UPTO 100T	I	5
3	PE-V0-426-501-A104	Mechanism Sizing Calculation for D/G EOT CRANE UPTO 100T	A	2
4	PE-V0-426-501-A105-1	General arrangement for BFP crane with CT DSL details	A	2
5	PE-V0-426-501-A105-2	General arrangement for CWPB crane with CT DSL details	A	2
6	PE-V0-426-501-A105-3	General arrangement for compressor house crane with CT DSL details	A	2
7	PE-V0-426-501-A106	Crab sub assembly for D/G EOT CRANE UPTO 100T with CT wheel assembly	I	3
8	PE-V0-426-501-A108	General arrangement for PVC shrouded DSL for D/G EOT CRANE UPTO 100T	I	3
9	PE-V0-426-501-A109	Main and Auxiliary hook block assembly with details of hook, nut and check plate For D/G EOT CRANE UPTO 100T	I	2
10	PE-V0-426-501-A110	Long travel Machinery Assembly with LT wheel assembly For D/G EOT CRANE UPTO 100T	I	4
11	PE-V0-426-501-A112	Structural calculations For D/G EOT CRANE UPTO 100T	A	3
12	PE-V0-426-501-A114	O & M Manual For D/G EOT CRANE UPTO 100T	I	9
13	PE-V0-426-501-A115	Detailed BOM/BOQ for D/G EOT CRANE UPTO 100T	I	8
14	PE-V0-426-501-A117/1	"Schematic circuit diagram of a) Protective panel, Main and lighting circuit & BOM b) Main hoist panel & BOM c) Aux. hoist panel & BOM d) Cross Traverse & BOM e) Long Traverse & BOM Including earthing diagram For BFP crane"	A	5

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15	PE-V0-426-501-A117/2	"Schematic circuit diagram of a) Protective panel, Main and lighting circuit & BOM b) Main hoist panel & BOM c) Aux. hoist panel & BOM d) Cross Traverse & BOM e) Long Traverse & BOM Including earthing diagram For CWPB crane"	A	5
16	PE-V0-426-501-A117/3	"Schematic circuit diagram of a) Protective panel, Main and lighting circuit & BOM b) Main hoist panel & BOM c) Aux. hoist panel & BOM d) Cross Traverse & BOM e) Long Traverse & BOM Including earthing diagram For compressor house crane"	A	5
17	PE-V0-426-501-A118	"General Arrangement of a) Protective panel b) Main hoist panel c) Aux. hoist panel d) Cross Travel panel e) Long Traverse travel panel. f) Pendant g) Remote Radio Control For D/G EOT CRANE UPTO 100T"	I	5
18	PE-V0-426-501-A119	Cable Sizing and cable schedule For D/G EOT CRANE UPTO 100T	A	6
19	PE-V0-426-501-A120	Crane Operational write up For D/G EOT CRANE UPTO 100T	I	5
20	PE-V0-426-501-A121	Type test certificate (for motors) For D/G EOT CRANE UPTO 100T	A	8
21	PE-V0-426-501-A123	Mandatory spare parts list For D/G EOT CRANE UPTO 100T	A	8
22	PE-V0-426-501-A125	Erection procedure For D/G EOT CRANE UPTO 100T	I	8
23	PE-V0-426-501-A127	Data sheet of D/G EOT CRANE UPTO 100T with painting details	A	3
24	PE-V0-426-501-A132	Gantry Rail installation for D/G EOT CRANE UPTO 100T	I	3
25	PE-V0-426-501-A150	Crane lubrication drawing For D/G EOT CRANE UPTO 100T	I	6
	LEGENDS			
	A= Approval category			
	I= Information category			

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.

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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.

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- j) Bidder to follow the following the drawing submission schedule:
- i. 1st submission of drawings from date of LOI as per the submission schedule.
 - ii. Every revised submission incorporating comments – within 7 days.
- k) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

B. DOCUMENT MANAGEMENT SYSTEM:

Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per dwg/ document distribution schedule. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized after award of contract.

Bidder to ensure following at their end

Internet explorer version – Minimum Internet Explorer 7

Internet speed 2 mbps (Minimum preferred)

Pop ups from our external DMS IP (124.124.36.198) should not be blocked

Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)

DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.

For quick access bidder may refer the link

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

C.



**TECHNICAL SPECIFICATION
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**ANNEXURE-VI
PACKING PROCEDURE**

Packing and Marking:

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

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

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

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

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ANNEXURE-VII

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

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

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%

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	(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 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 are 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

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manufacturers name.

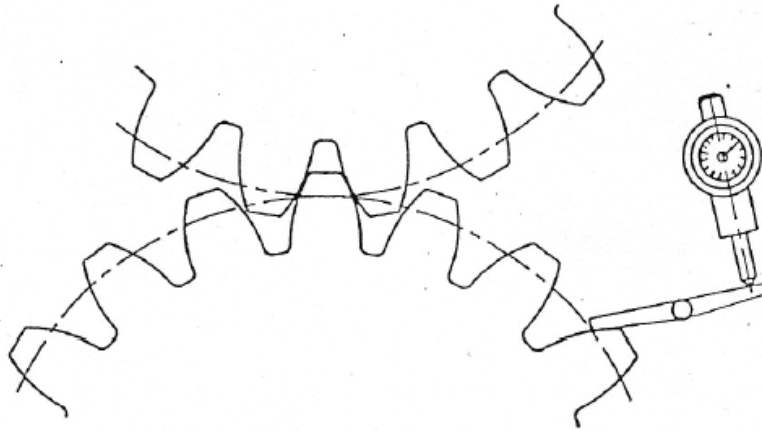


FIG.1 MEASUREMENT OF BACKLASH

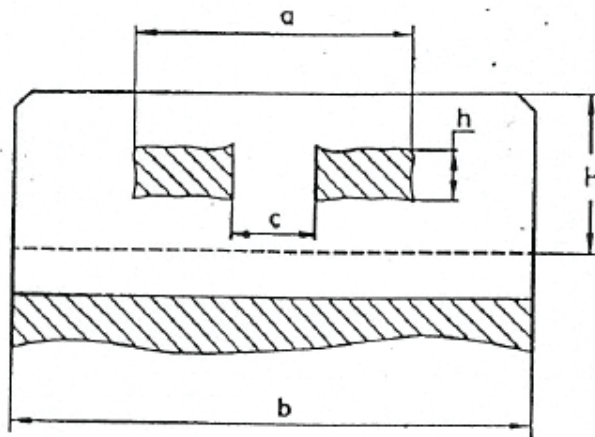


FIG.2 AREA OF CONTACT OF GEAR TEETH

Table-1



**TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN**

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Backlash for Gearing specified by module

(Clause 3.1.0)

Centre distance in mm		Tolerances in microns		
Above	Upto	Minimum	Maximum	
			For gears other than Drum gears	For Drum gears
			For all modules 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

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

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

Basic Assumptions / Inputs for testing at Works:

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

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Procedure for Load / Overload testing:

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

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

Hoisting & Cross Travel motions:

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

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

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

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

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

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

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Section - M3 : Shop Test for T.G. Hall EOT Cranes, Other Cranes & Hoist

- 1.0 Hooks
- 1.1 All tests including proof load test as per relevant IS/BS/DIN shall be carried out.
- 1.2 MPI/DPT shall be carried out after proof load test.
- 2.0 Steel Casting
- 2.1 DPT on machined surface shall be carried out
- 3.0 Girders, End Carriage, Crab, Gear Box and Rope Drum
- 3.1 The plates of thickness 25mm and above shall be Ultrasonically Tested.
- 3.2 NDT requirements on weldments shall be as follows
- a) BUTT WELDS IN TENSION - 100% RT AND 100% DPT
 - b) BUTT WELDS IN COMPRESSION - 10% RT AND 100% DPT
 - c) BUTT WELDS IN ROPE DRUM - 100% RT AND 100% DPT
 - d) FILLET WELDS - RANDOM 10% DPT
- 4.0 FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)
- 4.01 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonic testing.
- 4.02 DPT/MPI SHALL be done after hard facing and machining.
- 5.0 WIRE ROPE SHALL BE TESTED AS PER RELEVANT STANDARD
- 6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no-load run test to check for oil leakage, temperature rise, noise and vibration.
- 7.0 The cranes shall be completely assembled at shop for final testing. all tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per is-3177 shall be carried out at shop.



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FOR
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SECTION-I

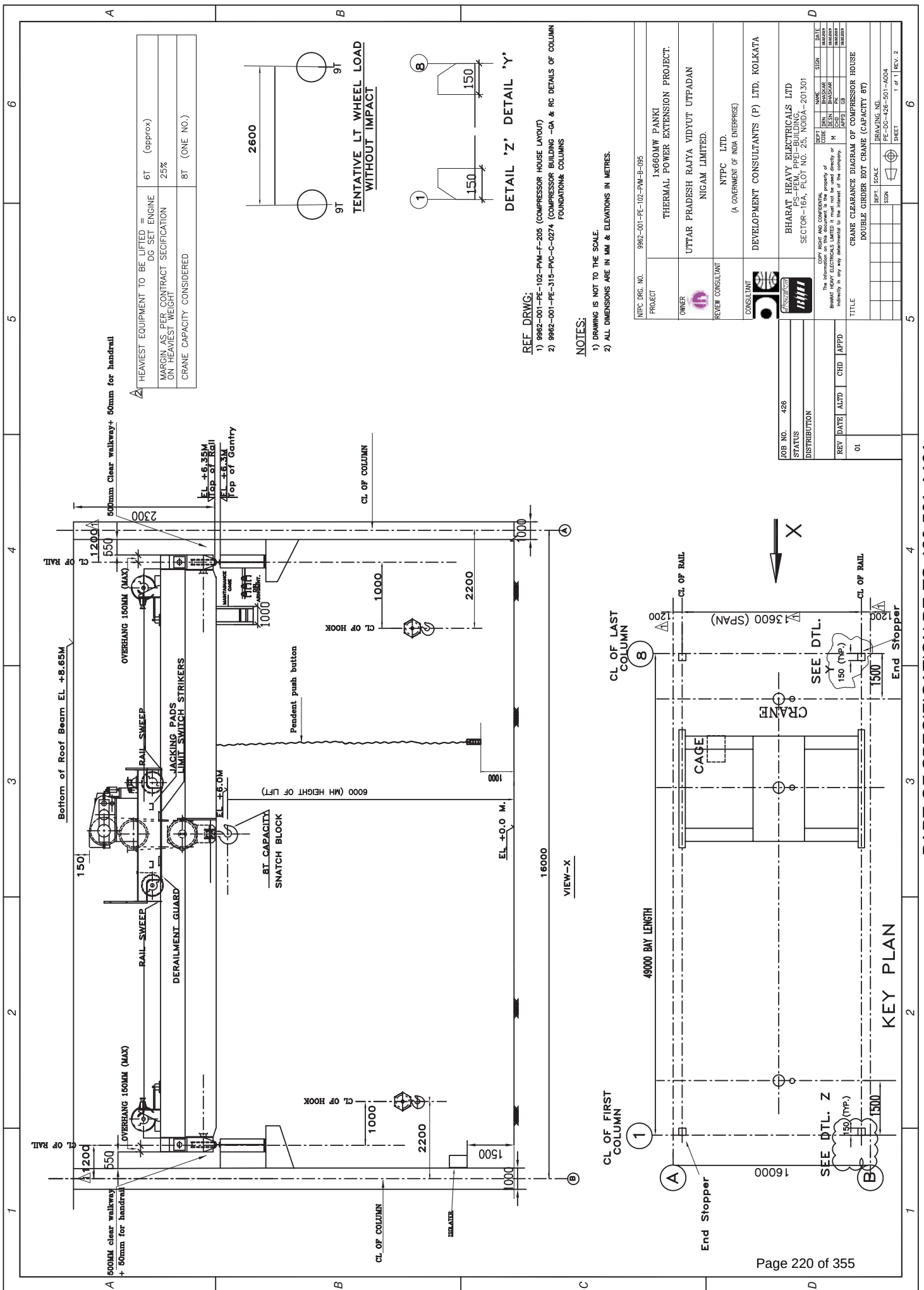
SUB-SECTION-IA

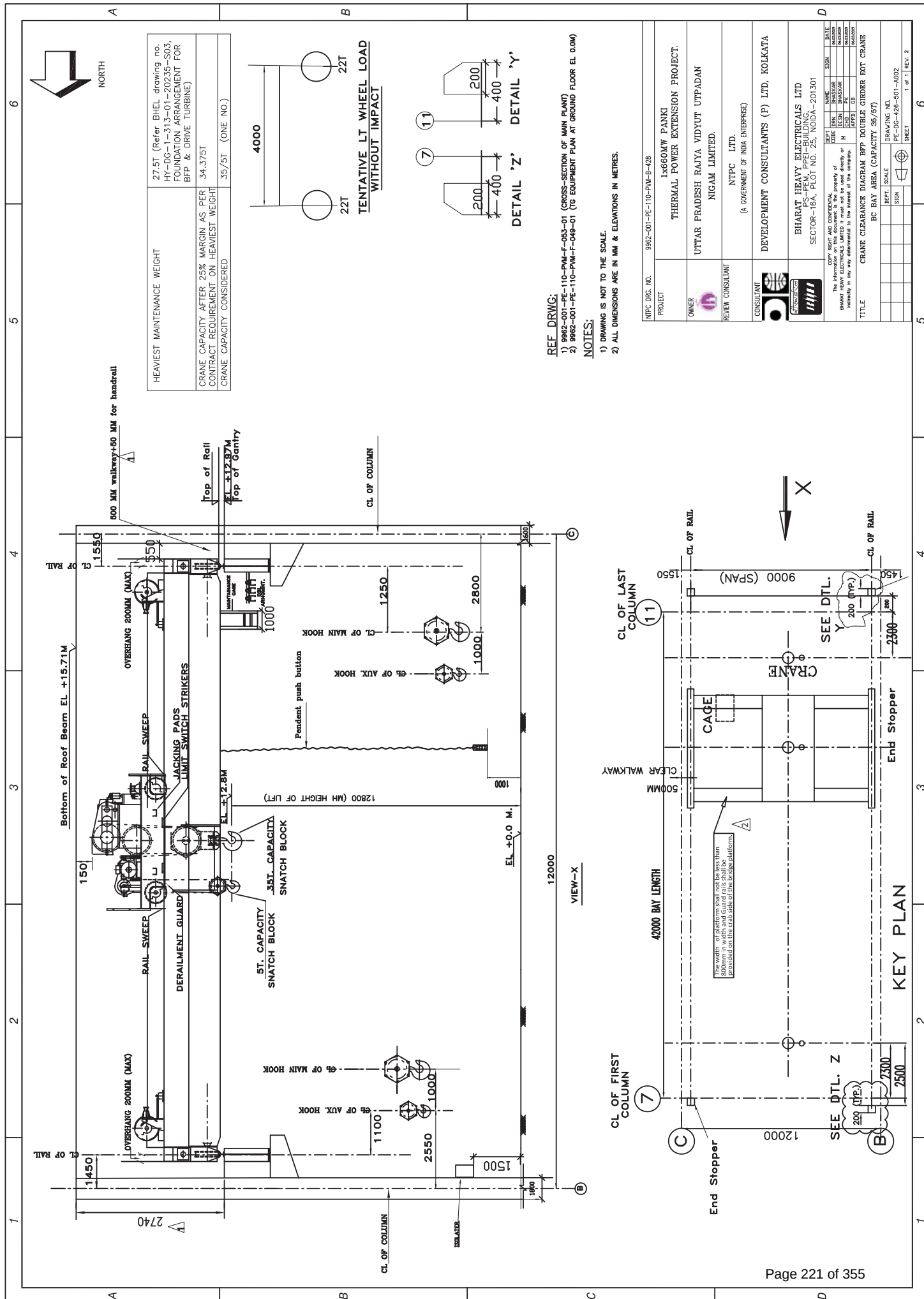
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ANNEXURE-IX
INPUT DRAWING

PART OF SPECIFICATION PE-TS-426-501-A101







TECHNICAL SPECIFICATION
FOR
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SUB SECTION-IB
SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)

PART OF SPECIFICATION PE-TS-426-501-A101

**UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM
LIMITED, INDIA**

1x660 MW PANKI TPS

**EOT CRANES & HOISTS TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT,
NOIDA, U.P., INDIA**

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

PACKAGE: DOUBLE GRIDER EOT CRANES

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

PROJECT :1X660 MW PANKI TPS

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



TITLE:

**DOUBLE GIRDER EOT CRANES & HOISTS
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)****1X660 MW PANKI TPS**

SPECIFICATION NO.

VOLUME NO. : **II-B**SECTION: **C**REV NO.: **00** DATE: 17/07/2018

SHEET: 1 OF 1

CONTENTS**List of enclosures:**

- a) Electrical scope between BHEL & vendor
- b) Customer (M/s DCPL) specification for Motors
- c) Customer (M/s DCPL) cabling spec (to be referred by vendor for their scope of work (as per Electrical scope between BHEL & vendor)).
- d) Quality plan for motors
- e) Datasheet (Annexure- I)
- f) Datasheet-C
- g) Electrical Load data format (Annexure –II)
- h) BHEL cable listing format (Annexure –III)
- i) Explanatory notes for cable listing

CHAPTER 17 : AC & DC MOTORS**1.00 MOTORS****1.1 SCOPE**

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

SITE CONDITIONS

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

1.2 Gases, Fumes & Dust Particles

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

1.2.02 Dust Particles

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

2 Indoor Locations.

2.1 Coal conveyors - As for outdoor as per clause 1.02.02.1 above.

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

1.2.03 Special Fumes

1 Water treatment plant and acid cleaning room - Acid and alkali fumes present.

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

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

1.3 LOCATION OF MOTOR - As required

1.4 **SPECIFICATIONS & STANDARDS**.....Motors shall comply with the latest revisions of all relevant standards of BIS (IS-325, IS-900, IS-996, IS-1231, IS-1885, IS-2148, IS-2223, IS-2253, IS-2254, IS-2848, IS-3202, IS-4029, IS-4691, IS-4722, IS-4728, IS-4889, IS-6362, IS-7816, IS-8223, IS-8789, IS: 12615, IS:3177 and IEC : 60034 3Φ Induction motor) except as modified herein or in driven equipment specification.

Motors conforming to BS or IEC Publications, which ensure equivalent quality shall also be acceptable. In case of any difference between IS Specification/International Standards (IEC; NEMA etc.), this motor specification prevails.

1.5 TYPE

1.5.1 AC Motors:

- a) Squirrel cage induction motor suitable for direct-on-line starting.
- b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg. C ambient temperature), shall be **Efficiency class-IE2**, conforming to IS 12615, or IEC:60034-30.
- c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

1.5.2 DC Motors Shunt wound.

1.6 VOLTAGE (NOMINAL)

1.6.1 LV Motors

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

1.6.2 MV MOTORS

For motors above 200kW upto and including 1500kW, Three point three (3.3) kV.

For CHP conveyors motor above 160 kW, 3.3 kV, AC supply is to be used. However all the motors on stacker reclaimer shall be on 415 V AC only.

1.6.3 HV Motors

For motors above 1500kW - eleven(11) KV

1.6.4 All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

1.7 FREQUENCY (NOMINAL) - fifty (50) Hertz

1.8 NUMBER OF PHASES - Three (3)

1.9 SPEED - As required by the driven equipment

1.10 TYPE OF STARTING :

Direct on-line (VFD/Soft-starter/star/delta starting in special cases)

1.11 DUTY

1.11.1 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment,

whichever is higher, considering highest system frequency and voltage variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

- 1.11.2 All HT motors shall have vibration pads for mounting vibration detectors.
- 1.11.3 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.
- 1.11.4 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.
- 1.11.5 All LV motors rated 0.37kW and higher with S1 duty shall be compulsorily be of energy efficiency level IE 2 as per IS 12615:2011.

Motors rated above 37kW shall have efficiency higher than 0.92 and high power factor of atleast 0.88.

1.12 **SUPPLY VARIATIONS**

Motors shall be capable of running continuously at full load under following variations in power supply:

- 1.12.1 All equipments shall be suitable for rated frequency of 50 Hz with a variation of (+) 3% and (-)5%, voltage variation of ($\pm$) 6% for 11 kV & 3.3 kV and ($\pm$)10% for 415V and 10% (absolute sum) combined variation of voltage and frequency unless specifically brought out in the specification.

1.13 **ABNORMAL CONDITIONS CAPABILITY**

Motor shall have following capabilities as specified design ambient temperature:

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

1.13.2 Low Voltage Running :

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

1.13.3 Momentary Low Voltage Withstanding :

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

1.14 **STARTING CAPABILITY**

1.14.1 Low Voltage Starting :

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80)

percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

1.14.2 Cold Motor Starting Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start will be made till lapse of further thirty (30) minutes.

1.14.3 Hot Motor Starting Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start will be made till lapse of further thirty (30) minutes.

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

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

1.14.5.1 Motors above 1500 KW upto 4000kW 600% without any positive tolerance except for ID Fan Motor.

1.14.5.2 Motors above 4000 KW 450%. Not subject to any positive tolerance.

1.14.5.3 For D.C. Motors the starting current shall be limited to 2 times full load current.

1.14.5.3 **Starting voltage requirement**

a) All Motors (except Mill Motors)

- 80% of rated voltage for Motors upto 4000 kW
- 75% of rated voltage for Motors above 4000 kW

b) For Mill Motors:

- 85% of rated voltage for Motors above 1000 kW
- 90% of rated voltage for Motors below 1000 kW

Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.

1.14.5.4 **Starting Time**

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

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

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

1.14.5.5 **Torque Requirements:-**

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

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

1.15 **SAFE STALL TIME**

1.15.1 To avoid problem in selecting standard protective relays without using speed switches, safe stall time under hot conditions (corresponding to 110% nominal voltage at motor terminals) shall be more than the accelerating time (corresponding to 80% nominal voltage at motor terminals) by the following minimum values :

1.15.1.01 Two (2) seconds, where accelerating time (at 80% nominal voltage) does not exceed 20 seconds.

1.15.1.02 Three (3) seconds, where accelerating time (at 80% nominal voltage) exceeds 20 seconds.

1.15.1.03 At no stage, speed switch shall be provided to achieve the above requirements mentioned under Clause No. 1.14.5.4

1.16 **CLASS OF INSULATION**

1.16.1 LV Motors Class F.

1.16.2 MV & HV Motors Class F

1.16.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both HT & LT motors. The temperature under abnormal running conditions shall be limited to 5°C above class 'B' limits.

1.16.04 The value of the polarization index for motors above 200kW should not be less than 2 when determined according to IS: 7816.

1.17 **TEMPERATURE RISE UNDER NORMAL CONDITIONS.....** Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
1.17.01	50°C	60°C	70°C
1.17.02	45°C	65°C	75°C
1.17.03	40°C	70°C	80°C

1.18 BUS TRANSFER WITHSTAND CAPABILITY

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

- 1.18.01 That about 5000 bus transfers, in lifetime of motor, shall not puncture its insulation.
- 1.18.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.
- 1.18.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.
- 1.18.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

1.19 TYPE OF ENCLOSURE

- 1.19.01 Outdoor Motors IP 55 (Additional canopy to be provided by EPC contractor.
- 1.19.02 Indoor Motors IP 55
- 1.19.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.
- 1.19.04 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:
- a) Fuel Oil area : Group IIB
 - b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034).

1.20 METHOD OF COOLING

- 1.20.1 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).
- 1.20.2 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

1.21 TYPE OF MOUNTING As required for the driven equipment.**1.21 MAXIMUM MECHANICAL VIBRATIONS**

- 1.21.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits



prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

1.21.02 Noise level

The noise level of motors shall not exceed 85 db (A) at 1m from operating motor measured in accordance with IS: 10265.

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

1.21.04 11 KV motors shall be offered with Separate Insulated Connector (Elastimould or Equivalent make) as per IEEE 386. The offered Elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.

1.21.05 3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.

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

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

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

Above 125 KW-upto 200 KW 203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

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

1.21.08 For motors rated 1500 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

1.21.09 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.

(a)	Below 110KW	:	10.0
(b)	From 110 KW & upto 200 KW	:	9.0
(c)	Above 200 KW & upto 1000KW	:	10.0
(d)	From 1001KW & upto 4000KW	:	9.0
(e)	Above 4000KW	:	6 to 6.5

1.22 WINDING & INSULATION

- (a) Type : Non-hygroscopic, oil resistant, flame resistant
- (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.
- (c) 11kV & 3.3 kV : Thermal class 155 (F) insulation.
AC motors
The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15
- (d) 240VAC, 415V : Thermal Class(B) or better
AC & 220V
DC motors

1.23 DIRECTION OF ROTATION

1.23.1 As needed by driven equipment.

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

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

1.24 BEARINGS



- 1.24.1 General Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 20,000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.
- Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.
- If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.
- Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.
- For MV & HV motors, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.
- When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.
- Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.
- Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.
- Bearings shall be of reputed make subject to the approval of the Owner/Consulting Engineer.
- 1.24.2 Large motors Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.
- 1.25 **SHAFT EXTENSION** Key slotted bare shaft extension of required length with key on driving end.
- 1.26 **DRAIN HOLES** Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.
- 1.27 **LIFTING DEVICES** Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- 1.28 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven

equipment assembly) or at site after erection (for separate supplies of above equipment).

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

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

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

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

1.31.1 Temperature rise under normal/abnormal conditions.

1.31.2 Type of bearing and recommended lubricants.

1.32 **FINISH**..... Motor shall have glossy, light grey finish No. 631 as per IS: 5 for withstanding site conditions as per Clause 1.00 above.

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

1.33 **TERMINAL BOXES**

1.33.1 General Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination of the type and tentative size of cables specified in Clause 1.34 below, however, exact size of cables shall be furnished by Owner during engineering stage.

The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HT motors shall be provided with phase segregated terminal box.

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

1.33.2 **Main Terminal Box**



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

1.33.2.2 MV & HV Motors Motor shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. These should be interchangeable to facilitate cable routing.

Neutral terminal box for HT motors rated above 1500 KW shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These transformers shall be supplied and mounted in the motor terminal box. In addition to above, 3 Nos. of identical current transformers shall be supplied loose for mounting in the switchgear. Stator phase terminal box may either be phase segregated or standard terminal box suitable for both top and bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable or push on type terminating Kit. Terminal leading shall be stud type or leading wire type.

1.33.2.3 Cable End Boxes.....Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables of sizes as specified in Clause 1.34 below.

Cable box shall be suitable for glanding the cables; and shall have adequate space between cable glands terminating studs to allow suitable bends of cable inside the cable box for all 3 phases of relevant cable sizes specified.

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

Min. fault level for MV Motors - 40 KA

Min. fault level for LV & HV Motors - 50 KA

1.33.2.5 **PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:**

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

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

1.33.2.6 Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes as specified in Clause 1.34 below.

1.34 **TYPE AND SIZE OF CABLES**

1.34.1 **Space Heaters**



- 1.34.1.1 For LV Motors: Two point five (2.5) mm², two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).
- 1.34.1.2 For MV & HV Motors: Six (6) mm² two core aluminium conductor PVC insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- 1.34.2 For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- 1.34.3 Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.
- 1.34.4 For Moisture Detectors.....As for space heaters as per Clause 33.01.01 above.
- 1.34.5 **For Main Terminals**

LT Motors

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

HT Motors

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

The size and no. of cable to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box, cable gland and lugs suitable for the same.

Cable size may be increased in some cases because of large number of cables in under-ground ducts or because of voltage drop consideration. The supplier shall supply with terminal box and cable accessories suitable for higher size of cable at no extra cost.

1.35 **EARTHING**

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



- 1.35.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.
- 1.35.03 MV & HV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.
- 1.36 **EMBEDDED TEMPERATURE DETECTORS**.....HT motor shall be provided with six (6) Nos. duplex resistance temperature detectors (RTDs) embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C
- 1.37 **BEARINGS TEMPERATURE INDICATORS**..... HT motors shall be provided with dial type two (2) bearing temperature indicators and will have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set will be set to operate at lower value to give alarm and other set at a higher value to trip the motor.
- 1.38 **SPACE HEATERS**.....Valve / Damper actuator motors; and Motors above 30 KW shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple. Motors upto 30 kW shall have stator windings suitable for connections to 24V, 50 Hz AC supply for space heating.
- Motors upto 30 kW shall have stator windings suitable for connection to 24V, 50 Hz ac supply for space heating
- The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.
- 1.39 **HOT AIR TEMPERATURE DETECTOR**
- If the motor is of CACA or CACW enclosure, a thermometer with alarm contracts in hot air circuit shall be provided.
- 1.40 **WATER FLOW INDICATOR**
- If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.
- 1.41 **MOISTURE DETECTORS**.....Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

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

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

1.44 **TYPE TEST**

1.44.01 **HT MOTORS**

- a) The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract.
- b) The type tests shall be carried out in presence of the Purchaser's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Purchaser's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
- c) In case the contractor has conducted such specified type test(s) within last five years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Purchaser's for waiver of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Purchaser's reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
- d) Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last five years from the date of bid opening. These reports should be for the test 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. However if 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 the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the Purchaser's either at third party lab or in presence of client representative and submit the reports for approval.

e) **LIST OF TYPE TESTS TO BE CONDUCTED**



The following type tests shall be conducted on each type and rating of HT motor

- i) No load saturation and loss curves upto approximately 115% of rated voltage
- ii) Measurement of noise at no load.
- iii) Momentary excess torque test (subject to test bed constraint).
- iv) Full load test(subject to test bed constraint)
- v) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

f) LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of HT motor

- i) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- ii) Terminal box-fault level withstand test for each type of terminal box of HT motors only.
- iii) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15
- iv) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

1.44.02

LT Motors

- a) LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Purchaser's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the test 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.
- b) However if 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 the case of type test report(s) are not found to be meeting the specification requirements, the Purchaser's shall conduct all such tests under this contract at no additional cost to the Purchaser either at third party lab or in presence of client representative and submit the reports for approval.

1.44.03

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

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The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

- i) Measurement of resistance of windings of stator and wound rotor.
- ii) No load test at rated voltage to determine input current power and speed.
- iii) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
- iv) Full load test to determine efficiency power factor and slip .
- v) Temperature rise test.
- vi) Momentary excess torque test.
- vii) High voltage test.
- viii) Test for vibration severity of motor.
- ix) Test for noise levels of motor(Shall be limited as per clause no 1.21.01 of this section)
- x) Test for degree of protection and
- xi) Over speed test.
- xii) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

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

1.45 INFORMATION WITH PROPOSAL

1.45.1 AC Motor Data Sheet.

1.45.2 Dimension Drawing/Foundation load details of motor and driven equipment.
1.45.03 Manufacturer's catalogue showing constructional details.

1.46.00 **INFORMATION ON AWARD OF CONTRACT**.....Within six (6) weeks from the date of award of the Contract, following shall be furnished:

1.46.01 Motor Data Sheet.

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

1.46.03 Following characteristics curves:

1.46.03.01 Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment.

1.46.03.02 Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage

1.46.03.03 Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.04 Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.



- 1.46.03.05 Efficiency, power factor, current and speed versus power output curves.
- 1.46.03.06 Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- 1.46.03.07 Negative phase sequence current withstand characteristics.

1.47 COMMISSIONING CHECK LIST (HT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box
6. Checking stator (motor air gap) Check – Grease lubrication (for ball or roller bearing) is adequate if the motor was in storage for very long period replace the grease, by fresh grease after flushing the bearing clean. Excess grease in the bearing (housing ... is overheat of bearings) Check the free rotation of the rotor in decoupled condition. Check the air gap between stator and rotor at four positions 90o apart at driving and non-driving end. Compare the recorded values with factory results. For slip ring motors : with starting resistances.
 - a) Check the variation of resistance
 - b) Check brush lifting and slip ring short.

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Measure resistance of motor winding (in case of large motors)
4. Control and interlocks should be checked
5. Motor protection relay to be calibrated
6. Phase sequence and direction of rotation
7. Other than DOL scheme to be checked example trafo starts
9. Measure starting current starting timer and no load current
10. On load operations starting and running currents (observed vibrations, temperatures of bearings and body)
11. On load operation, starting and running currents (observed vibrations, temperatures of bearings and body)
12. In case of forced water cooling of start or check winding temperatures as ready by built in RTDs.
13. Water level (start up cooling) low to be checked for limit switch operation.

1.48 COMMISSIONING CHECK LIST (LT MOTORS)**A PRELIMINARY CHECKS**

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Over load and short circuit relay tests and settings
4. Control and interlocks should be checked
5. Phase sequence and direction of rotation
6. Operation of timer in case of star delta starting
7. Measure starting current starting timer and no load current
8. On load operations starting and running currents

1.49 DC MOTOR SPECIFICATION

DC Motor will be of continuous duty type totally enclosed fan cooled (TEFC) having IP-54 degree of protection suitable for 220 V DC supply. DC motor will be shunt wound type having high torque characteristic suitable for Bi-directional rotation at rated speed and output. The general constructional features and details of DC motor will be in line with details/ particulars stipulated in the specification for AC squirrel cage induction motors.

Contractor will furnish the data in respect of DC motors.

DATASHEET

	Auxiliary power supply	
1.1	HV supply	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
1.2	MV supply	
	3.3kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors above 200kW upto and including 1500kW
	Fault level	40 kA for 1 second
1.3	LV supply	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
1.4	DC supply	
	220V, 2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	-----
	Frequency	-----
	Combined voltage & frequency	-----
2.2	DC supply	198 to 240 V
Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.		

CHAPTER 26 : CABLING SYSTEM**1.00.00 SCOPE OF WORK**

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

- (a) Main power house building.
- (b) Boiler area, ESP.
- (c) Transformer yard.
- (d) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the General electrical specification/ plot plan/ & related drawings.
- (e) Coal handling plant.
- (f) Ash handling plant including ash dyke
- (g) Raw water system
- (h) Fuel oil unloading & transfer system.
- (i) Aux. power transformers
- (j) Pipe cum cable rack.
- (k) All electrical equipment as described in different sections.
- (l) As built drawing for all above systems on completion of project.

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

2.00.00 SCOPE OF SUPPLY

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

- i. Power & control cabling works (including that of special cables):
- ii. Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.
- iii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.

- iv. Supply and installation (including laying & termination) of all power cables (HV and LV) of all power cables (HV and LV) for all equipments and systems.
- v. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.
- vi. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.
- vii. Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.
- viii. Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.
- ix. All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.
- x. Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the purchaser.

3.00.00 CODES AND STANDARDS

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

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.

IS:2309	Code of practice for the protection of building and allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron & steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:6745	Method for determination of mass of zinc-coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in-line connectors for aluminium conductors of insulated class.
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

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

4.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

4.00.01 Inter Plant Cabling

4.01.00

Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or only cable trestle except where approved by purchaser/consultant.

Major routes in boiler area to individual boiler drives, fly ash conveying compressor building, ESP building, CW pump house, Raw water pump house, DM plant, Filter water pump house, Clarified water pump house, Fly ash silo fluidizing blower house etc will be on overhead Cable trays either supported from available structures or on pipe cum cable trestle or on only cable trestle. Only in specific areas as will be approved by purchaser/consultant where number of cables are too small compared to the route length like Intake pump house & Ash dyke, cables may be directly buried underground with marker.

Overhead trestle will be provided to the extent possible. Cable route shall be provided in such a manner that movement of crane does not get restricted and also the cables are to be routed at a safe distance from hot pipes. Generally the bottom of steel supporting structure shall be at 6.5m above the grade level. Where rail/road crossing is involved the same shall be minimum at 8m above the grade level.

Individual shallow trench shall be routed from switchyard equipment to main switchyard trench which will be routed up to Switchyard control room. Interconnecting cables from Power House to Switchyard control room shall be routed through RCC trenches. From trenches to the switchyard equipments, all power and control cables shall be laid through PVC conduit.

Space for accommodating additional trays, which may come in future shall be provided in present cable route. Some trays may be required for use by the purchaser, which will be finalized during detail engineering stage. The successful bidder shall provide such trays without any extra cost to purchaser.

For Power supply to Raw Water Intake Pump house, Cable from powerhouse will run on overhead Cable trays up to Plant boundary. After that it will be buried cable that will follow the intake pipeline corridor.

For Power supply from Power House to Main CHP Substation Building and from Main CHP Substation Building to Crusher House & Pump House, Cable will run on overhead Cable trestles. Further, Cable shall be routed through the conveyor gallery / TPs / Crusher House by separate supporting structures and trench in the pump house.

4.02.00 Trenches

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

4.02.02

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

4.02.04 For CHP following shall also be applicable:

- a) All cable routes shall be overhead along the route of the conveyor gallery by separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600 mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 6.5 M above the grade level except for rail/road crossings where it shall be at 8.0 M above grade level. However in bunker area the bottom of the cable trestle shall be 10 to 14 M depending on boiler/bunker layout.
- b) Cable trenches shall be provided only in Switchgear/MCC rooms.
- c) **Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.**
- d) Cables for Pull cord switches and belt sway switches shall be taken in cable trays. The trailing cables of the mobile machines shall also be laid in cable trays.

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

Cable trays in Boiler & ESP area shall be supported from the Boiler & ESP structure. The same shall be co-ordinated with SG/ESP contractors

Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in Boiler/ESP area.

Contractor shall provide two independent routes for cables between ESP control room & ESP. Contractor shall provide the cable trays along with its supporting structure arrangement on the trestle.

f) **Turbine Hall Area:**

Two separate cable routes shall be provided for cable routing of working & standby drives or different sets/groups say 50% capacity) of auxiliaries.

g) **OffSite Area:**

In offsite area pumphouses, overhead cable tray arrangement shall be preferably followed.

h) **Cable Vault:**

Cable gallery (over ground) to be provided below each electrical control/switchgear room .

Cable vault of not less than 3 mts clear height from bottom of beam shall be provided.

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

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

Each cable vault should have two doors.

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

5.00.00 EQUIPMENT DESCRIPTION

5.01.00 Cable trays, Fittings & Accessories

- 5.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts,

washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

5.01.02 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

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

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

5.01.05 Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of maximum 1.25M for horizontally and 1.0M for vertically unless design is approved for larger span. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.

In areas, where acid/alkalie ingration is likely to occur, glass reinforced plstic trays with fire retardant corrosion resistance properties shall be used.

5.01.06 Cable trays fabricated from standard rolled sections shall be 50x50x6/75x75x6 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32x6 mm / 50x6 flat for widths up to 500mm/more than 500mm respectively.

5.01.07 Separate coloured paint strips shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables: red strips, 2 inch width each, numbers
11kv/3.3kv equally spaced at 5 metres interval
1.1kv power cables : yellow strips ----- do -----
1.1kv control cables : blue strips ----- do -----
Instrumentation cables : green strips ----- do -----

5.02.00 Support System for Cable Trays

5.02.01 Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

5.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor

plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

- b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.
- c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
- d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
- e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.
- f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
- g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

5.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

5.03.00 Pipes, Fittings & Accessories

- 5.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.)
- 5.03.02 The size of the pipe shall be selected on the basis of maximum 40% fill criteria
GI Pipes shall be of medium duty as per IS: 1239.
- 5.03.03 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.
- 5.03.04 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

- 5.03.05 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.
- 5.03.06 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.
- 5.03.07 Flexible conduits complying to relevant IS and made with bright, cold_rolled, annealed and electro_galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.
- 5.03.08 Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

5.04.00 Junction Boxes

- 5.04.01 Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

5.04.02 Glass Fibre Reinforced Junction Boxes (for outdoor use)

No. of Ways: 12/24/36/48 with 20% spares terminals.

- 5.04.03 Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100°C. Impact resistance shall be greater than 7 Nm, (EN 50014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/mm, halogen free toxicity, the enclosure and door cover shall be painted and electro statically power coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

5.04.04 Doors

With integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.05 Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing

rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.06 **Mounting clamps and accessories**

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.

5.04.07 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage into the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.08 **Steel Junction Boxes (for indoor use)**

5.04.09 No. of Ways

12/24/36/48 with 20% spares terminals.

5.04.10 Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18,19 & 20 or equivalent standards.

5.04.11 Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

5.04.12 Doors

The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.13 Protection Class

Protection Category shall be IP 66 to EN60529/1091 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data

sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.14 Mounting clamps and accessories

The mounting clamps and accessories shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass.

5.04.15 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.16 Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

5.04.17 Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

5.04.18 Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

5.04.19 Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm. Al. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

5.05.00 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, lock nuts, marking strips etc.

Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Cage clamp type terminal block suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination shall be provided.

5.06.00 Terminations & Straight through Joints

5.06.01 Termination and jointing kits for 11/3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/3.3 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

5.06.02 Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 3.3 kV systems.

5.06.03 1.1 KV grade straight through joints shall be of proven design.

5.07.00 Cable glands

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

5.07.02 Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE. Cable glands shall match with the sizes of different HT/LT/Control cables.

5.08.00 Cable lugs/ferrules

5.08.01 The cables lugs shall be conforming to IS: 8309.

5.08.02 Machine ferruling shall be adopted.

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

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

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

- i) Copper tubular terminal end for solder less crimping to copper conductors.
- ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the panel.
- iii) Pin type lugs shall not be used.
- iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

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

5.09.00 Cable Clamps & Straps

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

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

5.10.00 Galvanizing

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

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

5.11.00 Welding

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

6.00.00 CONSUMABLES AND HARDWARE

- i. The contractor shall furnish all erection materials, hardware and consumables required to complete the installation.
- ii. The materials shall include but not limited to the following:
- iii. Consumables: Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
- iv. Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
- v. Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

7.00.00 METHODS AND WORKMANSHIP

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

- ii. The erection work shall be supervised by competent supervisors holding relevant supervisory license from the government.
- iii. All details on installation shall be electrically and mechanically correct.
- iv. The installation shall be carried out in such a manner as to preserve access to other equipment installed.

8.00.00 INSTALLATION**8.00.01 Cable tray and Support System Installation**

08.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP, AHP & ESP areas.

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

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

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

9.00.00 Conduits/Pipes/Ducts Installation

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

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



- 9.03.00 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.
- 9.04.00 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.
- 9.05.00 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

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

- 9.06.00 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.
- 9.07.00 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

10.00.00 Junction Boxes Installation

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

11.00.00 Cable Laying and Installation

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

and aligning and leveling as required shall be the responsibility of the contractor.

- 11.02.00 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.
- 11.03.00a. In outdoor areas, buried cables, wherever called for, shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.
- b. When buried cables cross road/railway track, additional protection shall be provided in the form of hume / galvanised iron pipes/RCC box culvert.
- 11.04.00 For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.
- 11.05.00 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The contractor shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the contractor. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.
- 11.06.00 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.
- 11.07.00 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.

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

12.00.00 Laying of cables in cable trays

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

12.02.00 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.

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

12.03.00 Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

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

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

12.06.00 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and

- cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.
- 12.07.00 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends. the hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.
- 12.08.00 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of owner.
- 12.09.00 Joints for less than 250 Meters run of cable shall not be permitted.
- 12.10.00 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
- 12.11.00 Wherever few cables are branching out from main trunk route troughs shall be used.
- 12.12.00 Cables shall be neatly arranged in the trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trays shall be the responsibility of the contractor.
- 12.13.00 The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical contractor and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the contractor. During the erection period the contractor shall furnish a monthly report on cable position in an approved proforma so as to keep the owner apprised of the position.
- 12.14.00 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.
- 12.15.00 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.
- For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.
- 12.16.00 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

12.17.00 Separation

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

At least 300mm clearance shall be provided between :

- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

12.19.00 Segregation

Segregation means physical isolation to prevent fire jumping.

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

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

13.00.00 Cable fire sealing

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

13.02.00 Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one-twenty (120) minutes shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

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

14.00.00 Cable laying in trenches

14.01.00 RCC cable trenches with removable covers will be provided by the contractor. Cables shall be laid in 3 or 4 tires in these trenches. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of

cable laying and reinstating them in their proper positions after the cables are laid shall be done by the contractor at no extra cost.

- 14.02.00 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.
- 14.03.00 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover till such times the final termination to the equipment is completed.
- 14.04.00 Prior to laying of cables inside both indoor and outdoor trenches, the contractor shall properly clean inside of those trenches.
- 14.05.00 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.
- 14.06.00 As each row of cables is laid in place and before covering with sand every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.
- 14.07.00 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.
- 14.08.00 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.
- 14.09.00 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

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

- a) 1 cable in pipe - 53% full
- b) 2 cables in pipe - 51% full
- c) 3 or more cables - 43% full
- d) Multiple cables - 40% full

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

- 14.10.00 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or

structures, the electrical contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

15.00.00 CABLE IDENTIFICATION

15.01.00 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

15.02.00 For laying of underground cable (applicable for Raw Water Intake Switchgear & Ash dyke) shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription 'Cable Joint'. For buried cables the marker shall project 150mm above ground.

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

16.00.00 CABLE TERMINATIONS & CONNECTIONS

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

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

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

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

- 16.05.00 Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.
- 16.06.00 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.
- 16.07.00 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.
- 16.08.00 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.
- 16.09.00 It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.
- 16.10.00 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.
- 16.11.00 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.
- 16.12.00 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.
- 16.13.00 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.
- 16.14.00 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.
- 16.15.00 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

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

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

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

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

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

- 16.18.00 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least one-twenty (120) minutes.

17.00.00 Cable accessories for H.V. Systems

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

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

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

- a. 'PUSH ON' type for LV cables.
- b. Heat-shrinkable sleeve type for LV & HV cables.

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

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

- 17.04.00 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

- a. 'TAPEX' of M-seal make or equivalent for LV cables
- b. Heat-shrinkable sleeve type for LV & HV cables.

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

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

18.00.00 EXCAVATION AND BACK FILLING

18.01.00 The contractor shall perform all excavations and backfilling as required for buried cable and ground connections.

18.02.00 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

18.03.00 The contractor shall make use of his own arrangement for pumping out any water that may be accumulated in the excavation.

18.04.00 All excavation shall be backfilled to the original level with good consolidation.

19.00.00 CLEANING UP OF WORK SITE

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

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

20.00.00 QUALITY ASSURANCE PROGRAMME

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

21.00.00 TESTS

21.01.01 Type tests on Cable Trays support system

A) Test 1A:

On main support channel type-C2 for cantilever arms fixed on one side only.

A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:

i) Working load

- ii) Working load + point load
- iii) Off load
- iv) Proof load + point load
- v) Off load

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) Test 1B:

Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a) Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

- i) Working load
- ii) Working load + Point load

iii) Off load

- iv) Proof load + Point load
- v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) Test 2B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3:

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as detailed below and other important points not mentioned herein.

a) Test 3A : A length of steel structure shall be rigidly supported. It should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

- b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.
- c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.
The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:

A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing.

With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM No fewer than three measurements shall be made or each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 5 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

Cable termination kit and straight through joints should have been tested as per IS: 13573 for 3.3kV and 11kV class.

Fire proof Cable Penetration system should have been tested for the following tests:

- Accelerated Ageing test
- Water absorption test
- Fire rating test
- Hose Stream test
- Vibration test followed by fire rating test

21.02.00 Routine/ Acceptance Tests

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

22.00.00 Galvanizing Tests



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

- i) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
- ii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.
- iii) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

23.00.00 Welding

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

- 1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.
- 2). The weld metal shall be properly fused with the parent metal without undercutting.
- 3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.
 - 1. Physical and dimensional checks for all items.
 - 2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
 - 3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
 - 4. Deflection test cable trays.
 - 5. All acceptance and routine tests on Junction boxes.
- 6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:
 - i) Physical and Dimensional checks
 - ii) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
 - iii) Check chemical composition of brass parts for cable glands.
 - iv) Hardness check on gaskets.
 - v) Test for uniformity of galvanization.

24.00.00 Cable trays / supports and accessories

- 1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
- 2) Check for continuity of cable trays over the entire route.
- 3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
- 4) Check for earth continuity and earth connection of cable trays.

PART OF SPECIFICATION PE-TS-426-501-A101

QUALITY PLAN FOR MOTORS BELOW 55 KW (LV)

SL. NO.		CUSTOMER :		PROJECT		SPECIFICATION :	
		BIDDER/ VENDOR		TITLE		NUMBER :	
COMPONENT/OPERATION		QUALITY PLAN		QUALITY PLAN		SPECIFICATION	
SHEET 1 OF 2		SYSTEM		ITEM AC/ELECT. MOTORS BELOW 55KW (LV)		TITLE	
1	2	3	4	5	6	7	8
1.0	ASSEMBLY	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM
2.0	PAINTING	1.WORKMANSHIP 2.DIMENSIONS 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE 1.SHADE	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC. 2.OVERALL DIMENSIONS & ORIENTATION	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7
BHEL			PARTICULARS	BIDDER/VENDOR			
			NAME				
			SIGNATURE				

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
		SHEET 2 OF 2		BIDDER/ :		QUALITY PLAN		SPECIFICATION : TITLE :					
		SYSTEM		NUMBER PED-506-00-Q-006, REV-01		SECTION				VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10	11			
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-		
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW . ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.													
<u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY													
BHEL		PARTICULARS		BIDDER/VENDOR									
		NAME											
		SIGNATURE											
		DATE											
BIDDER'S/VENDORS COMPANY SEAL													

QUALITY PLAN FOR MOTORS 55 KW & ABOVE

CUSTOMER :			PROJECT		SPECIFICATION :					
TITLE			TITLE		NUMBER :					
BIDDER/ VENDOR			QUALITY PLAN		SPECIFICATION :					
SYSTEM			NUMBER PED-506-00-Q-007_REV-03		TITLE					
CAT.			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION					
CHARACTERISTIC CHECK			REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		VOLUME III REMARKS	
EXTENT OF CHECK			TYPE/ METHOD OF CHECK		P		W		V	
SHEET 1 OF 9			4		5		6		7	
3			8		9		10		11	
2			1		2		3		4	
1			1.0		1.1		1.2		1.3	
1.4			1.5		1.6		1.7		1.8	
1.9			2.0		2.1		2.2		2.3	
2.4			2.5		2.6		2.7		2.8	
2.9			3.0		3.1		3.2		3.3	
3.4			3.5		3.6		3.7		3.8	
3.9			4.0		4.1		4.2		4.3	
4.4			4.5		4.6		4.7		4.8	
4.9			5.0		5.1		5.2		5.3	
5.4			5.5		5.6		5.7		5.8	
5.9			6.0		6.1		6.2		6.3	
6.4			6.5		6.6		6.7		6.8	
6.9			7.0		7.1		7.2		7.3	
7.4			7.5		7.6		7.7		7.8	
7.9			8.0		8.1		8.2		8.3	
8.4			8.5		8.6		8.7		8.8	
8.9			9.0		9.1		9.2		9.3	
9.4			9.5		9.6		9.7		9.8	
9.9			10.0		10.1		10.2		10.3	
10.4			10.5		10.6		10.7		10.8	
10.9			11.0		11.1		11.2		11.3	
11.4			11.5		11.6		11.7		11.8	
11.9			12.0		12.1		12.2		12.3	
12.4			12.5		12.6		12.7		12.8	
12.9			13.0		13.1		13.2		13.3	
13.4			13.5		13.6		13.7		13.8	
13.9			14.0		14.1		14.2		14.3	
14.4			14.5		14.6		14.7		14.8	
14.9			15.0		15.1		15.2		15.3	
15.4			15.5		15.6		15.7		15.8	
15.9			16.0		16.1		16.2		16.3	
16.4			16.5		16.6		16.7		16.8	
16.9			17.0		17.1		17.2		17.3	
17.4			17.5		17.6		17.7		17.8	
17.9			18.0		18.1		18.2		18.3	
18.4			18.5		18.6		18.7		18.8	
18.9			19.0		19.1		19.2		19.3	
19.4			19.5		19.6		19.7		19.8	
19.9			20.0		20.1		20.2		20.3	
20.4			20.5		20.6		20.7		20.8	
20.9			21.0		21.1		21.2		21.3	
21.4			21.5		21.6		21.7		21.8	
21.9			22.0		22.1		22.2		22.3	
22.4			22.5		22.6		22.7		22.8	
22.9			23.0		23.1		23.2		23.3	
23.4			23.5		23.6		23.7		23.8	
23.9			24.0		24.1		24.2		24.3	
24.4			24.5		24.6		24.7		24.8	
24.9			25.0		25.1		25.2		25.3	
25.4			25.5		25.6		25.7		25.8	
25.9			26.0		26.1		26.2		26.3	
26.4			26.5		26.6		26.7		26.8	
26.9			27.0		27.1		27.2		27.3	
27.4			27.5		27.6		27.7		27.8	
27.9			28.0		28.1		28.2		28.3	
28.4			28.5		28.6		28.7		28.8	
28.9			29.0		29.1		29.2		29.3	
29.4			29.5		29.6		29.7		29.8	
29.9			30.0		30.1		30.2		30.3	
30.4			30.5		30.6		30.7		30.8	
30.9			31.0		31.1		31.2		31.3	
31.4			31.5		31.6		31.7		31.8	
31.9			32.0		32.1		32.2		32.3	
32.4			32.5		32.6		32.7		32.8	
32.9			33.0		33.1		33.2		33.3	
33.4			33.5		33.6		33.7		33.8	
33.9			34.0		34.1		34.2		34.3	
34.4			34.5		34.6		34.7		34.8	
34.9			35.0		35.1		35.2		35.3	
35.4			35.5		35.6		35.7		35.8	
35.9			36.0		36.1		36.2		36.3	
36.4			36.5		36.6		36.7		36.8	
36.9			37.0		37.1		37.2		37.3	
37.4			37.5		37.6		37.7		37.8	
37.9			38.0		38.1		38.2		38.3	
38.4			38.5		38.6		38.7		38.8	
38.9			39.0		39.1		39.2		39.3	
39.4			39.5		39.6		39.7		39.8	
39.9			40.0		40.1		40.2		40.3	
40.4			40.5		40.6		40.7		40.8	
40.9			41.0		41.1		41.2		41.3	
41.4			41.5		41.6		41.7		41.8	
41.9			42.0		42.1		42.2		42.3	
42.4			42.5		42.6		42.7		42.8	
42.9			43.0		43.1		43.2		43.3	
43.4			43.5		43.6		43.7		43.8	
43.9			44.0		44.1		44.2		44.3	
44.4			44.5		44.6		44.7		44.8	
44.9			45.0		45.1		45.2		45.3	
45.4			45.5		45.6		45.7		45.8	
45.9			46.0		46.1		46.2		46.3	
46.4			46.5		46.6		46.7		46.8	
46.9			47.0		47.1		47.2		47.3	
47.4			47.5		47.6		47.7		47.8	
47.9			48.0		48.1		48.2		48.3	
48.4			48.5		48.6		48.7		48.8	
48.9			49.0		49.1		49.2		49.3	
49.4			49.5		49.6		49.7		49.8	
49.9			50.0		50.1		50.2		50.3	
50.4			50.5		50.6		50.7		50.8	
50.9			51.0		51.1		51.2		51.3	
51.4			51.5		51.6		51.7		51.8	
51.9			52.0		52.1		52.2		52.3	
52.4			52.5		52.6		52.7		52.8	
52.9			53.0		53.1		53.2		53.3	
53.4			53.5		53.6		53.7		53.8	
53.9			54.0		54.1		54.2		54.3	
54.4			54.5		54.6		54.7		54.8	
54.9			55.0		55.1		55.2		55.3	
55.4			55.5		55.6		55.7		55.8	
55.9			56.0		56.1		56.2		56.3	
56.4			56.5		56.6		56.7		56.8	
56.9			57.0		57.1		57.2		57.3	
57.4			57.5		57.6		57.7		57.8	
57.9			58.0		58.1		58.2		58.3	
58.4			58.5		58.6		58.7		58.8	
58.9			59.0		59.1		59.2		59.3	
59.4			59.5		59.6		59.7		59.8	
59.9			60.0		60.1		60.2		60.3	
60.4			60.5		60.6		60.7		60.8	
60.9			61.0		61.1		61.2		61.3	
61.4			61.5		61.6		61.7		61.8	
61.9			62.0		62.1		62.2		62.3	
62.4			62.5		62.6		62.7		62.8	
62.9			63.0		63.1		63.2		63.3	
63.4			63.5		63.6		63.7		63.8	
63.9			64.0		64.1		64.2		64.3	
64.4			64.5		64.6		64.7		64.8	
64.9			65.0		65.1		65.2		65.3	
65.4			65.5		65.6		65.7		65.8	
65.9			66.0		66.1		66.2		66.3	
66.4			66.5		66.6		66.7		66.8	
66.9			67.0		67.1		67.2		67.3	
67.4			67.5		67.6		67.7		67.8	
67.9			68.0		68.1		68.2		68.3	
68.4			68.5		68.6		68.7		68.8	
68.9			69.0		69.1		69.2		69.3	
69.4			69.5		69.6		69.7		69.8	
69.9			70.0		70.1		70.2		70.3	
70.4			70.5		70.6		70.7		70.8	
70.9			71.0		71.1		71.2		71.3	
71.4			71.5		71.6		71.7		71.8	
71.9			72.0		72.1		72.2		72.3	
72.4			72.5		72.6		72.7		72.8	
72.9			73.0		73.1		73.2		73.3	
73.4			73.5		73.6		73.7		73.8	
73.9			74.0		74.1		74.2		74.3	
74.4			74.5		74.6		74.7		74.8	
74.9			75.0		75.1		75.2		75.3	
75.4			75.5		75.6		75.7		75.8	
75.9			76.0		76.1		76.2		76.3	
76.4			76.5		76.6		76.7		76.8	
76.9			77.0		77.1		77.2		77.3	
77.4			77.5		77.6		77.7		77.8	
77.9			78.0		78.1		78.2		78.3	
78.4			78.5		78.6		78.7		78.8	
78.9			79.0		79.1		79.2		79.3	
79.4			79.5		79.6		79.7		79.8	
79.9			80.0		80.1		80.2		80.3	
80.4			80.5		80.6		80.7		80.8	
80.9			81.0		81.1		81.2		81.3	
81.4			81.5		81.6		81.7		81.8	
81.9			82.0		82.1		82.2		82.3	
82.4			82.5		82.6		82.7		82.8	
82.9			83.0		83.1		83.2		83.3	
83.4			83.5		83.6		83.7		83.8	
83.9			84.0		84.1		84.2		84.3	
84.4			84.5		84.6		84.7		84.8	
84.9			85.0		85.1		85.2		85.3	
85.4			85.5		85.6		85.7		85.8	
85.9			86.0		86.1		86.2		86.3	
86.4			86.5		86.6		86.7		86.8	
86.9			87.0		87.1		87.2		87.3	
87.4			87.5		87.6		87.7		87.8	
87.9			88.0		88.1		88.2		88.3	
88.4			88.5		88.6		88.7		88.8	
88.9			89.0		89.1		89.2		89.3	
89.4			89.5		89.6		89.7		89.8	
89.9			90.0		90.1		90.2		90.3	
90.4			90.5		90.6		90.7		90.8	
90.9			91.0		91.1		91.2		91.3	
91.4			91.5		91.6		91.7		91.8	
91.9			92.0		92.1		92.2		92.3	
92.4			92.5		92.6		92.7		92.8	
92.9			93.0		93.1		93.2		93.3	
93.4			93.5		93.6		93.7		93.8	
93.9			94.0		94.1		94.2		94.3	
94.4			94.5		9					

		CUSTOMER :		PROJECT		SPECIFICATION :									
QUALITY PLAN		BIDDER/ VENDOR		TITLE		NUMBER :									
		SYSTEM		QUALITY PLAN		TITLE									
		CAT.		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION									
SHEET 2 OF 9		CHARACTERISTIC CHECK		EXTENT OF CHECK		TYPE/ METHOD OF CHECK		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS	
SL. NO.	COMPONENT/OPERATION	2	3	4	5	6	7	8	9	10	P	W	V	VOLUME III	
1														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-	MANUF'R'S DRG.	LOG BOOK	3	-	2			
			4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUF'R'S SPEC.	-DO-	3	2	1		FOR DIA OF 55 MM & ABOVE	
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S			MA	VISUAL	-DO-	MANUF'R'S DRG. SPEC.	MANUF'R'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	MANUF'R'S DRG./ SPEC.	MANUF'R'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											

SPECIFICATION : NUMBER :			PROJECT TITLE			CUSTOMER :			QUALITY PLAN			SPECIFICATION : TITLE																				
BIDDER/ : VENDOR			NUMBER PED-506-00-Q-007, REV-03			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION AGENCY			VOLUME III REMARKS																				
SHEET 3 OF 9			REFERENCE DOCUMENT			ACCEPTANCE NORM			FORMAT OF RECORD																							
SL. NO.			COMPONENT/OPERATION			CHARACTERISTIC CHECK			SYSTEM CAT.			TYPE/METHOD OF CHECK			EXTENT OF CHECK			7			8			9			10			11		
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 (PUNCHEDED)			1. SURFACE COND.			MA			VISUAL			100%			-			NO VISUAL DEFECTS (FREE FROM BURS)			LOG BOOK			3	-	-			
						2.DIMENSIONS INCLUDING BURS HEIGHT			MA			MEASUREMENT			SAMPLE			MANUF'S DRG. .			MANUF'S DRG.			-DO-			3	-	2	FOR MV MOTOR INSULATION/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																				

CUSTOMER :				PROJECT		SPECIFICATION :						
QUALITY PLAN				TITLE		NUMBER :						
				BIDDER / VENDOR	SYSTEM	QUALITY PLAN		TITLE				
SHEET 4 OF 9				NUMBER PED-506-00-Q-007 .REV-03		SECTION		VOLUME III				
COMPONENT/OPERATION		CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS		
SL. NO.	2	3	4	5	6	7	8	9	P	W	V	
1									10			
									11			
1.10	BEARINGS	3.DIMENSIONS 1.MAKE & TYPE 2.DIMENSIONS 3.SURFACE FINISH	MA MA MA MA	MEASUREMENT VISUAL MEASUREMENT VISUAL	-DO- 100% SAMPLE 100%	-DO- MANFR'S DRG./ APPROVED DATASHEET BHEL DATA SHEET -	-DO- MANFR'S DRG./ APPROVED DATASHEET BHEL DATA SHEET BEARING MANUF'S CATALOGUES FREE FROM VISUAL DEFECTS	Log Book -DO- -DO- -DO-	3 3 3 3	- - - -	2 2 2 2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE (COND. 2.DIMENSIONS 3.TEMP.WITH- STAND CAPACITY	MA MA MA	VISUAL MEASUREMENT ELECT.TEST	100% SAMPLE -DO-	-DO- MANUF'S DRG MANUF'S SPEC./ BHEL SPEC.	-DO- MANUF'S DRG MANUF'S SPEC./ BHEL SPEC.	-DO- -DO- -DO-	3 3 3	- - -	- - 2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET 2.SURFACE COND. 3.DIMENSIONS	MA MA MA	-DO- VISUAL VISUAL MEASUREMENT	100% 100% 100% SAMPLE	-DO- MANUF'S DRG/SPECS - MANUF'S DRG	-DO- MANUF'S DRG/ SPECS. FREE FROM VISUAL DEFECTS MANUF'S DRG	-DO- -DO- -DO- -DO-	3 3 3 3	- - - -	2 - - -	
BHEL												
PARTICULARS						BIDDER/VENDOR						
NAME												
SIGNATURE												
DATE												
BIDDER'S/VENDORS COMPANY SEAL												

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :	
				BIDDER/ VENDOR		TITLE		NUMBER :	
				SYSTEM		QUALITY PLAN		SPECIFICATION :	
		SHEET 5 OF 9		CAT.		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		TITLE	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	VOLUME III REMARKS
1	2	3	4	5	6	7	8	9	10
2.0	IN PROCESS								11
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNES	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2 -
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG		-DO-	2 -
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2 -
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG		-DO-	2 -
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ASTM-E165		-DO-	2 - 1
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC./BHEL SPEC./RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2 -
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-		-DO-	2 -
		3.SHADE	MA	VISUAL	-DO-	-DO-		Log Book	2 -
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-		Log Book	2 -
BHEL		PARTICULARS		BIDDER/VENDOR					
		NAME							
		SIGNATURE							
		DATE							
								BIDDER'S/VENDORS COMPANY SEAL	

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

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :			
SHEET 7 OF 9		BIDDER/ : VENDOR		TITLE		NUMBER :		SPECIFICATION :			
COMPONENT/OPERATION		SYSTEM		QUALITY PLAN		NUMBER PED-506-00-Q-007, REV-03		TITLE		VOLUME III	
SL. NO.	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION		REMARKS	
								P	W	V	
1	2	3	4	5	6	7	8	9	10	11	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1
		1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2	1	1
2.9	COMPLETE ROTOR ASSEMBLY	3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	1	1
		1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2	1	VERIFICATION FOR MV MOTOR ONLY
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2	1	
		1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-
		5.CORRECTNESS, COMPLETENESS/ TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
										BIDDER/SVENDORS COMPANY SEAL	

品質管理		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
SHEET 8 OF 9		BIDDER/ VENDOR :		SYSTEM		QUALITY PLAN		SPECIFICATION : TITLE					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY			VOLUME III REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
3.0	TESTS	1. TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC. 2. ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC. 3. VIBRATION & NOISE LEVEL 4. OVERALL DIMENSIONS AND ORIENTATION 5. DEGREE OF PROTECTION 6. MEASUREMENT OF RESISTANCE OF RTD & BTD 7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER 8. NAMEPLATE DETAILS 9. EXPLOSION FLAME PROOF NESS (IF SPECIFIED) 10. PAINT SHADE, THICKNESS & FINISH	MA	ELECT. TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1	
			MA	-DO-	100%	-DO-	-DO-	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2
			MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2
			MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-		
			MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3	
			MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1 ^{\$}	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2	
BHEL													
PARTICULARS			BIDDER/VENDOR										
NAME													
SIGNATURE													
DATE													
BIDDER'S/VENDORS COMPANY SEAL													



PART OF SPECIFICATION PE-TS-426-501-A101

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :				
				BIDDER/ VENDOR :		TITLE		NUMBER :				
SHEET 9 OF 9		QUALITY PLAN		NUMBER PED-506-00-Q-007, REV-03		TITLE		SPECIFICATION :				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	VOLUME III			
										SECTION AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	10			11
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL												
PARTICULARS												
NAME												
SIGNATURE												
DATE												
BIDDER/VENDOR												
BIDDER'S/VENDORS COMPANY SEAL												

	TITLE	ANENEXURE – I LV MOTORS DATA SHEET-A	SPECIFICATION NO.	
			VOLUME	
			SECTION	
			REV NO. 00	DATE 11.07.2018
			SHEET 1	OF 1

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	≤200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP55
5.0	Type of Cooling	:	Refer clause 1.20 of Customer Motor Specification.
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10%
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes	:	
	○ 90kW & Above (Breaker controlled)	:	50 kA for 1 sec
	○ Below 90kW (MCCB Contactor controlled)	:	50 KA for 01 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Refer clause 1.16 of Customer Motor Specification
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	Refer clause 1.14.5.3 & 4 of Customer Motor Specification
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	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 kW
13.0	Tests	:	Refer clause 1.44.02 of Customer Motor Specification
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement

- Also detail Customer spec. for Motors to be referred as enclosed with the specification.

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	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 29/08/2005
		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	

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	TITLE MOTOR DATA SHEET - C	SPECIFICATION NO.
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		SHEET 2 OF 2

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 $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

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ANNEXURE III

[illegible]

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

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

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

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.



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SUB SECTION-IC
DATA SHEET-A

TABLE -1							
S.N.	AREA / EQUIPMENT DESCRIPTION	Type	QTY (nos)	CAPACITY (T)	LIFT (M)	SPAN (M)	TRAVEL (M)
1	CWPH	DOUBLE GIRDER EOT CRANE	1	70/5T	22.95/22.95	13	36.45
2	BC bay	DOUBLE GIRDER EOT CRANE	1	35/5T	12.8/12.8	9	42
3	COMPRESSOR HOUSE	DOUBLE GIRDER EOT CRANE	1	8T	6	13.6	49



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

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



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	a.	Main hoist	1.6 MPM	0.16 (10% of main speed thru' VVVF drives)
	b.	Aux. hoist	7.5 MPM	0.75 (10% of main speed thru' VVVF drives)
	c.	Trolley travel (CT)	4.0 MPM	0.4 (10% of main speed thru' VVVF drives)
	d.	Longitudinal bridge travel (LT)	8.0 MPM	0.8 (10% of main speed thru' VVVF drives)
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 Metres	The lifting rope shall have 2 full turns in drums at the zero level.	
	a.	Main Hoist	Refer Table -1 above	
	b.	Aux Hoist	Refer Table -1 above	
2.4.0		Hook Approaches	Refer Crane clearance diagrams attached	
2.5.0		Hand Rail Pipes	32 mm NB Medium class of IS : 1161 having top and bottom rail at height of 1050 mm and 600 mm and vertical post spacing not exceeding 1500 mm with provision of kick plate(100 mm high and 6 mm thick).	
3.0.0		COMPONENT DETAILS		
3.1.0		Trolley	The trolley frame shall be built up from heavy steel plates, angles and channels adequately braced to resist vertical, lateral and torsional strains, welded to form a rigid one piece frame. Alternatively, it may be of cast steel construction and should be covered by flooring as far as possible. On bottom of trolley frame, on each side a double spring bumper shall be provided to engage stops at each end of the bridge.	
	a.	Type	Fabricated	
	b.	Method of fabrication	Fusion welded	
	c.	Material	Mild steel, grade 'B' of IS 2062 in 100% killed rolled section norm alised and ultrasonically tested quality or high strength steel of IS 8500 as appropriate	
	d.	Centre to centre distance of wheels (on the same rails)	*	
	e.	Whether jacking pads for lifting trolley provided or not	Yes	
3.2.0		Rope drums	Main hoist	Aux. Hoist



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



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	d.	Coupling material and hardness	All couplings shall be of cast, wrought or from forged steel, tooth portion to be heat treated to hardness HB241-280			
3.5.2		Coupling details (between gear box and wheels)	Cross Travel (CT)		Long Travel (LT)	
	a.	Type	Flexible geared type			
	b.	Size & Torque rating	*			
	c.	Guards and enclosures provided	Yes			
3.5.3		Coupling details (between gear box and rope drum)	Main hoist		Aux. Hoist	
	a.	Type	Flexible joint, incorporating flexible geared coupling housed within the drum.			
	b.	Size	*			
	c.	Guards and enclosures provided	Yes			
3.5.4		Shafting (Output)	Cross Travel		Long Travel	
	a.	Diameter in mm	*		*	
	b.	Factor of Safety	As per IS: 3177-			
	c.	Number of support bearings	*		*	
	d.	Type of support bearing	*		*	
	e.	Arrangement of lubrication	Grease cups / Nipple			
	f.	Type of lubricant	Grease			
	g.	Max unsupported length of shaft in mm	*		*	
3.6.0		Gear box details				
3.6.1		Hoist Motions	MH	MH Micro	AH	AH micro
	a.	Type of mounting of gear box	Horizontal / Vertical			
	b.	Classification	Suitable for M5 duty			
	c.	Total number of reductions	*	Thru' VVVF drive	*	Thru' VVVF drive
	d.	Type of gears	Helical		Helical	
	e.	Reduction ratio	*			
	f.	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication			
	g.	Hardness (BHN) – gear	*			
	h.	Hardness (BHN) – pinion	*			
	i.	Difference in Gear and	Min 20 BHN			



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		pinion hardness				
	j.	Materials (gear/pinions)	Main Gears En 9/ 55C8/ IS2707 Gr. 1or 2. Pinions En 19/EN 24. Hardness conforming to IS: 3177 (latest edition) Gears to be hardened, tempered & heat treated as per IS 4460			
	k.	Casings	Fabricated Fe 410w IS: 2062 Gr B & stress relieved			
	l.	Noise level	85 db	NA	85 db	NA
	m.	Standard conforming to	IS: 4460 / AGMA			
3.6.2		Travel Motions	CT	CT micro	LT	LT micro
	a.	Type of mounting gear box	Vertical/ Horizontal	NA	Vertical/ Horizontal	NA
	b.	Classification	M5 duty			
	c.	Total number of reduction	*	Thru' VVVF drive	*	Thru' VVVF drive
	d.	Type of gears	Helical		Helical	
	e.	Reduction ratio	*		*	
	f.	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication			
	g.	Hardness (BHN) – gear	*			
	h.	Hardness (BHN) – pinion	*			
	i.	Difference in Gear and pinion hardness	Min 20 BHN			
	j.	Materials (gear / pinions)	Main Gears En 9/ 55C8/ IS2707 Gr. 1or 2. Pinions En 19/EN 24. Hardness conforming to IS: 3177 (latest edition) Gears to be hardened, tempered & heat treated as per IS 4460			
	k.	Casings	Fabricated Fe 410w IS: 2062 Gr B & stress relieved			
	l.	Standard conforming to	IS: 4460 / AGMA			
3.7.0		Wheels details	Cross travel		Long travel	
	a.	Material	C55 Mn 75/ En9 (55 C 8)			
	b.	Hardness	300 – 350 BHN			
	c.	Depth of hardness	10 mm (min)			
	d.	Tread diameter in mm	*		*	
	e.	Tread width in mm	*		*	
	f.	Process of hardening	Volume hardening			
	g.	Type	Double flanged			
	h.	Specification conforming to	IS: 3177			
	i.	Arrangement of lubrication	Grease			
3.8.0		Lifting hooks	MH		AH	
	a.	Type	Ramshorn shank with safety latch swivelling type as per		Plain with safety latch swiveling type as per latest edition of IS: 15560	



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



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	h.	Braking distance in mm	*		NA	*	NA	
3.10.2		Travel Motions	CT		CT micro	LT		LT micro
	a.	Type of brake (ac / dc / thruster)	AC Electro-Hydraulic Thruster operated + DC electro magnetic					
	b.	Dia of brake in mm	*		NA	*	NA	
	c.	Torque rating Kg.M	*			*		
	d.	Number provided per motor	1+1			1+1		
	e.	Braking capacity (% of motor rated torque before derating)	125%			125%		
	f.	Braking torque actually required	*			*		
	g.	Material						
		• Brake liners	Ferrodo liners					
		• Drum	CS IS : 1030 / CL4 IS : 1875					
		• Springs	As per manufacturers standard					
		• Thrusters	*					
	h.	Braking distance in mm	*		NA	*	NA	
3.11.0		Drive system for hoisting						
	a.	Arrangement of drive from motor to rope drum (main)	Through geared coupling and gear box					
	b.	Arrangement of drive from pony motor to rope drum (creep speed)	NA					
3.12.0		Bearings	Crane hook	Trolley wheels	Rope drum	Gear box	Any other assembly	
	a.	Type	Antifriction ball / roller bearings					
	b.	Number provided for each	As per assembly requirements					
	c.	Method of lubrication	Centralised grease lubrication with hand operated grease pump for all bearings as per bidder's standard proven practice.					
	d.	Bearing life	10,000 working hours or 20 years whichever is earlier					
3.13.0		Bridge girder						
	a.	Type & Quantity	Box type – 2 nos. Material: Mild steel, grade 'A/B' of IS 2062 in 100% killed, normalised and ultrasonically tested quality or high strength steel of IS 8500 as appropriate.					
	b.	Size	*					
	c.	Vertical Deflection &	The total maximum vertical deflections for the girder for the safe					



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		Camber	weight of working load plus the weight of crab in central position (Without taking in to consideration the impact factor) will not exceed limit of span/900. Girders shall be cambered to an amount approximately equal to the dead load deflection plus one-half the live load deflection."			
	d.	Type of connection to end carriage	By fitted bolts			
	e.	Width	*			
	f.	Length	*			
3.14.0		Rails				
	a.	Type / section	Rails sections as per IS: 3443 Grade 50 C 12. Joint to be butt-welded by thermit welding & fusion welding or by end clamping method			
	b.	Standard conforming to	IS: 3443			
	c.	Weight per metre	*			
	d.	Material	50C12			
	e.	Top width in mm	*			
	f.	Height in mm	*			
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	Platforms / walkways in crane shall be provided for maintenance with 750 mm clear inside width. Non-skid steel plate of thickness 6 mm with toe guards of 100 mm height above the floor level and safety hand railing shall be provided along the full span length on either side of the crane bridge girders. The hand railings shall consist of 32 mm NB pipe in two (2) tiers. Top pipe shall be at about one (1) m and middle pipe shall be at about 450 mm height from the walkway platform level.			
	c.	Type of access from gantry girder level to crane bridge	Rung ladder at ends from gantry girder level walkway to crane bridges walkway			
	d.	Type of access to maintenance cage from crane bridges walkway	Rung ladder			
	e.	Provided at both ends	Yes			
3.16.0		End carriage span (wheel base)	As per IS 807 (latest edition)			
3.17.0		Motors				
3.17.1		Hoist Motions	MH	MH micro	AH	AH micro
	a.	Type	Three phase squirrel cage induction motors to be operated from VFD	Thru VVVF drive	Three phase squirrel cage induction motors to be operated	Thru VVVF drive



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			system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty		from VFD system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty.	
	b.	Enclosure	TEFC	NA	TEFC	NA
	c.	Numbers furnished	One per motion			
	d.	Voltage, phase and frequency	415V + 10%, 3 Ph, 3 wire, 50 Hz, $\pm 5\%$ Combined voltage & frequency variation = 10% absolute			
	e.	Class of protection	IP – 55			
	f.	Rated capacity (KW)	All drive motors will be of crane duty conforming to IS: 325 and IS: 3177. Motor nameplate rating at 50 deg C. Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.			
	g.	Duration factor/duty	60 % CDF / S-4			
	h.	Speed (rpm)	*			
	i.	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B			
	j.	Number of starts/ hour	300 starts / hr			
	k.	Contactors for motor	*			
	l.	Overload protection for motors provided	Yes			
	m.	Space heater requirements	For motors of rating 30 KW and above			
	n.	Pull out torque	Shall not be less than 275% of rated torque			
	o.	Additional features	Operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals. Withstand 120% of rated speed for two minutes. Current shall not exceed 6 times full load current for creep speed motor. Withstanding the stresses imposed if started at 110% rated voltage. Start with rated load and accelerate to full speed with 80% rated voltage at motor terminals. The locked rotor motor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 3 seconds for motors upto 20 seconds starting time. Maximum torque shall not be below 200% of full load torque			



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PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)

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3.17.2		Travel Motions	CT	CT micro	LT	LT micro
	a.	Type	Three phase squirrel cage induction motors to be operated from VFD system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty.	Thru VVVF drive	Three phase squirrel cage induction motors to be operated from VFD system. Motors shall be provided with VPI insulation and insulated bearing on one side and shall be suitable for inverter duty.	Thru VVVF drives
	b.	Enclosure	TEFC	NA	TEFC	NA
	c.	Numbers furnished	1	NA	2	NA
	d.	Voltage, phase and frequency	415V + 10%, 3 Ph, 4 wire, 50 Hz, $\pm 5\%$ Combined voltage & frequency variation = 10% absolute			
	e.	Class of protection	IP – 55			
	f.	Rated capacity (KW)	All drive motors will be of crane duty conforming to IS: 325 and IS: 3177. Motor nameplate rating at 50 deg C. Motor ratings shall be 25% (at least) over the maximum power requirement.			
	g.	Duration factor/duty	60 % CDF / S-4			
	h.	Speed (rpm)	*			
	i.	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B			
	j.	Number of starts/ hour	300 starts / hr			
	k.	Contactors for motor	*			
	l.	Overload protection for motors provided	Yes			
	m.	Space heater requirement	For motors of rating 30 KW and above			
	n.	Pull out torque	Shall not be less than 275% of rated torque			
	o.	Additional features	Operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals. Withstand 120% of rated speed for two minutes. Current shall not exceed 6 times full load current for creep speed motor. Withstanding the stresses imposed if started at 110% rated voltage. Start with rated load and accelerate to full speed with 80% rated voltage at motor terminals. The locked rotor motor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 3 seconds for motors			



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			upto 20 seconds starting time. Maximum torque shall not be below 200% of full load torque			
3.18.0		Limit switches	Main hoist	Aux. hoist	Cross Travel	Long Travel
	a.	Type	Rotary gear + Gravity		Lever type (two way)	
	b.	Number provided	1+1	1+1	1	1
	c.	Rating of contacts	*			
	d.	Material of contacts	Double break Silver Cadmium			
	e.	Control voltage / Enclosure	110 V/ IP 55			
3.20.0		Power conductors (DSL)				
	a.	Type	LT: PVC shrouded Cu conductor bus bar. CT: Flexible trailing cable mounting on retracting support (Festoon type) ERP insulated Cu conductor as per IS:9968			
	b.	Size	Shall be sized with a margin of 10% 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.	Length	Suitable for bay length			
	d.	Guard provided	Yes			
3.21.0		Protective Panel	20 % spare terminals to be provided in panel			
	a.	Size	*			
	b.	Material	Sheet steel 2 mm size			
	c.	DOP	IP 55			
3.22.0		Control panel	20 % spare terminals to be provided in panel			
	a.	Size	*			
	b.	Material	Cold Rolled sheet steel 2mm size			
	c.	Numbers and location	One each for MH, AH, CT and LT located on bridge platform with space heaters.			
	d.	Degree of protection	IP 54			
3.23.0		Maintenance cage	Suitable inspection cages to accommodate two persons to facilitate inspection of down shop lead.			
3.24.0		Control for Hoists /CT/LT operations	Through Variable Voltage Variable frequency drive			
	a.	Speed control	Thru' VVVF with 1024 pulse incard, droop control for synchronization and crane software.			
	b.	Rating of VVVF	The rating of VVVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.			
	c.	Duty	Continuous duty as per IEC 146 (clause II).			
	d.	Output frequency range	Shall be minimum 0 to 50 Hz at constant torque and 0 to 100 Hz at constant power.			



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	e.	Efficiency	Minimum 97%.	
	f.	General	Individual converters shall be provided for each vector drive. The harmonic content reflected on incoming line is to be limited to 5% THD and 3% for individual harmonics. Harmonics filters preferably along with 12 pulse converter/IGBT based converter shall be used to achieve this.	
3.25.0		Cable	Power	Control
	a.	Material / Type	EPR insulated, copper conductor trailing cables, as per IS: 9968, on the bridge. Extruded PVC insulated, copper/Aluminium conductor, 1100 Volt grade power cables. This shall include cable lengths between changeover switch & DSL and isolating switch & DSL. Extruded PVC insulated, copper conductor 1100 volt grade control cables.	
	b.	Size	Min. 2.5 mm ² for Cu.	Min. 2.5 mm ² for Cu.
	c.	Voltage grade	1100 V	
	d.	Voltage drop	Cable from main isolating switch (1.5M above operating floor) to motor terminal shall be so sized that the voltage drop does not exceed 3% of rated voltage at motor terminals.	
	e.	Trailing cable	EPR insulated, copper conductor trailing cables, as per IS: 9968, on the bridge.	
3.26.0		Earthing		
	a.	Material of earthing	G.I / Copper	
	b.	Earthing as per specification	Yes	
3.27.0	a.	Contactors	AC 4 duty for reversing application. AC 3 duty for non-reversing application	
	b.	Switches	AC 23 for motor application, AC 22 for other application.	
	c.	Fuses	HRC	
	d.	Overload relay	Temperature compensated bi metallic with single phasing preventor.	
3.28.0		Power supply	Owner shall provide one (1) no. 415 V, 3 phase, 3 wire supply at operating floor near A row column at centre of bay length shall be provided. Bidder shall provide change over switch in enclosure to receive above power supply.	
3.29.0		Transformer		
	a.	Quantity	2 X 100 % for control, 1 no for lighting & 1 no for hand lamp.	
	b.	Voltage Rating	Control 415/110V, Lighting 415/240V and hand lamp 415/24V.	
	c.	KVA rating	20% over loading to be considered while sizing the rating	
3.30.0		Illumination		
	a.	Over Bridge	4 Nos. 10W LED Bulkhead Walkway light and 4nos. 3 pin industrial socket	
	b.	Under bridge	2 nos 250 W HPSV lamps for other double girder cranes	
	c.	For inspection of crane components	One (1) portable 40W SLS hand lamp with enclosed type battery and wire guard with min. half span length flexible cable for	



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			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.
3.31.0		Fire Extinguisher	
	a.	Type and size	4.5 kg CO ₂ type
	b.	Location	Two on bridge
3.32.0		Type of control for Hoists/ CT/LT operation	Through VVVF drive
3.33.0		VVVF drive	The VVVF drive shall be equipped at least with 1024 pulse incard, droop control for synchronization and crane software. The rating of VVVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.
3.34.0		Load cell	For overload protection of hoisting motion

Note: Other requirements for the system.

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



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T a l H a l l a T a e

MAIN HOIST MOTOR SELECTION :-

$$\text{Hoisting Power Required } P = \frac{(Q + q) \times V \times C_v \times C_{df} \times MF}{6120 \times E} \times \frac{1}{\text{Camb}} \quad (\text{IS: 3177 page no 52})$$

Q = Load to be lifted in kg 43750 (25% margin on SWL as per specification)

q = Weight of Bottom Pulley Block in kg+ Hook Wt in kg+ weight of wire rope 1750 (Considering 5% of SWL i.e. 35T)

V = Main Hoisting Speed in m/min 1.6

MF = Multifaction factor for motor qty. 1

Cv = Service Factor 0.67

E = Combined Efficiency for Gears & Sheaves
(0.95)ⁿ x (0.99)^m

n = Nos .of Pairs of Gears. 3

m = Total number of Rotating Sheaves 5

Passed over by each part of the moving rope attached to the drum

E = Combined Efficiency for Gears & Sheaves 0.815

Cdf = Duty Factor as per Electrical 1.4 (for M5 class)

Electrical duty Class

Camb= Ambient Temperature derating factor for 50 ° C 0.88

Motor KW Rating Required P = 15.56

Considering 25% Margin On Motor KW. 19.45

MOTOR DETAILS :

TYPE OF MOTOR
CDF OF MOTOR
ST/HR OF MOTOR
QTY. OF MOTOR
INSULATION

Squirrel
Cage
60%
300
1
CLASS-F / B

ENCLOSURE
PROTECTION

TEFC
IP-55



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SPECIFIC TECHNICAL REQUIREMENT

SUB-SECTION IIA

**STANDARD TECHNICAL REQUIREMENT
(MECHANICAL)**

PART OF SPECIFICATION PE-TS-426-501-A101



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STANDARD TECHNICAL REQUIREMENT (MECHANICAL)



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DOUBLE GIRDER EOT CRANE

1.0.0 SCOPE

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

2.0.0 CODES AND STANDARDS

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

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



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xvii)	IS: 1653	Steel conduits for general engineering purposes.
xviii)	IS: 2509	Rigid non-metallic conduit for electric-Installations
xix)	IS: 2062	Steel for General Engineering purposes.
xx)	IS: 1030	Carbon Steel castings for general engineering purposes.
xxi)	IS: 1570	Schedules for Wrought steels.
xxii)	IS: 1875	Carbon steel billets, blooms, slabs and bars for forgings.
xxiii)	IS: 808	Dimensions for hot rolled steel beam, column, channel and angle sections.
xxiv)	IS: 1852	Rolling and cutting tolerances for Hot rolled steel products.
xxv)	IS: 2291	Tangential Keys and Keyways.
xxvi)	IS: 2292	Taper Keys and Keyways.
xxvii)	IS: 3961	Recommended current rating for cables.
xxviii)	IS: 694	PVC insulated cables for working voltages up to and including 1100V)
xxix)	IS: 1554 (part-I)	PVC insulated (heavy duty) electric cables: 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.



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



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



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



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



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

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

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

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

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

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

3.3.0 **MECHANICAL**

3.3.1 **Rope drums**

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

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

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



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3.3.2 Hoist ropes

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

3.3.3 Rope sheaves

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

3.3.4 Wheels

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

3.3.5 Buffer

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

3.3.6 LT drive

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

3.3.7 CT drive

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

3.3.8. Gearing

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



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

3.3.9 Gear Box

3.3.9.1 All gears shall be completely covered and enclosed in oil tight casing & sealed with gasket. In case of totally enclosed gearboxes, splash or automatic lubrication system shall be used. Covers shall be split horizontally at each shaft centre line, so that top half can be removed for inspection and repair without 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 whichever is higher. Facial clearance between inner surface of gearbox and face of gear or pinion shall be at least 20 mm. Gearbox shall be inspected in line with QP and as per PEM (Q)/001 enclosed.

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

3.3.10 Bearing

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

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

3.3.11. Shafts, Couplings and axles

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



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radius and /or be tapered to avoid stress concentration.

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

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

3.3.12 Repair Cage

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

3.3.13 Lifting hook

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

3.3.14 LIFTING HOOK BLOCK ASSY

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

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

3.3.15 Brakes

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

i) SERVICE BRAKE



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

ii) **HOIST CONTROL**

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

3.4.0 **ELECTRICAL**

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

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

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

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

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

3.4.2 **DRIVE MOTORS**

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



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

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

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

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

3.4.3 Limit switches

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

3.4.4 Switch

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

3.4.5. Contactors.

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

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



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

3.4.6 Push button and lamp

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

3.4.7 Protective Panel

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

The following minimum equipment shall be provided.

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



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

3.4.8 Starter Panel

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

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

3.4.9 MOTOR CONTROL PANEL

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

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



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

3.4.11 Illumination

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

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

3.4.13 Grounding

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

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



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Separately.

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

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

3.4.15 Wiring Systems

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



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1.0 General

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

- b) Inverter construction and related devices:

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

- c) Programming of VVVF Drives.

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

- d) VVVF drives shall be connected with power supply and these drives generate their own low voltage control supply. Potential free contacts shall be connected to this control supply and few programmable control terminals. Starting / stopping / set speeds operations of VVVF drive shall be achieved by above control connection.
- e) VVVF shall give smooth control over acceleration and deceleration making the motion jerk free and using Variable voltage variable frequency limits the inrush current to the squirrel cage motors. VVVF provides controlled torque to the motor due to which crane operations are jerk free.

1.1 Experience

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

1.2 Local support



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

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

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

2.0 Basic requirements for the AC Drives

2.1 General requirements

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

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

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

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

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



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

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

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

Suitable encoder shall be provided for all motions.

3.0 User interface

3.1 General

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

3.2 Inputs and outputs

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

Analogue Inputs	:	1 x Programmable differential voltage input $\pm 10V$, 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



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

All the control terminals shall be clearly marked.

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

Analogue input	Analogue outputs
Speed reference 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



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FOR VVVF DRIVE

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

SECTION -IIB

Rev 00

5 OF 5

vi) Motor Speed

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

i) Drive Status

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

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

3.5 Application programming

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

3.6 PC Tools

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

4.0 Software features

A. Restart

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

B. Brake logic control

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

5.0 Preferred makes:

As per attached sub-vendor list

SITE STORAGE AND PRESERVATION GUIDELINES FOR MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)



PROJECT ENGINEERING MANAGEMENT, POWER SECTOR
BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

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

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.
11. Following preservatives/preservation methods can be used depending upon type of equipment
 - a. Rust preventive fluid (RPF)
 - b. Rust protective paints
 - c. Tarpaulin covers, in case of outdoor storage
 - d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –
 - Ingress of moisture and corrosion damages.
 - Damage to protective coating.
 - Open ends in pipes, vessels and equipment -
 - In case any open ends are noticed, same shall be capped.
2. Any damages to equipment / materials.
 - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
 - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere. (C)**

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.



ii **Semi-closed storage. (S)**

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.





iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.



The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self- life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self- life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

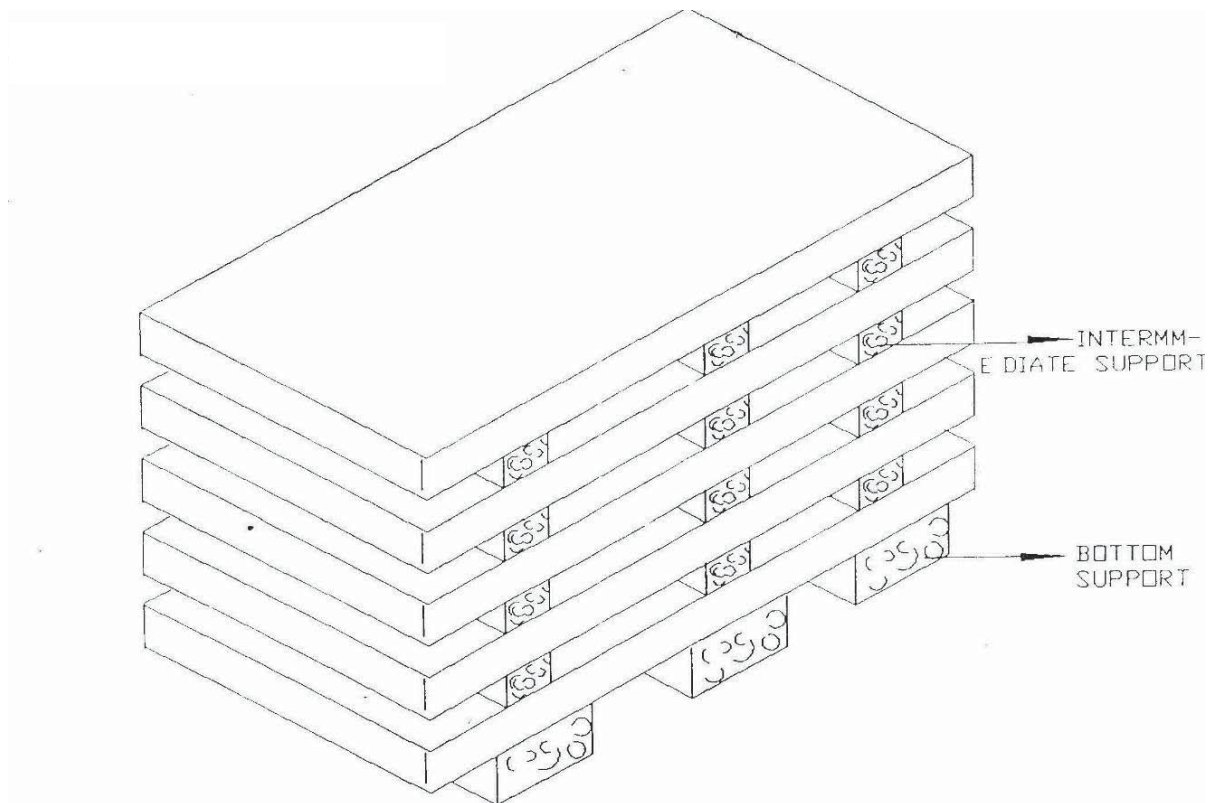


Figure – 1 – PLATE STACKING ARRANGEMENT

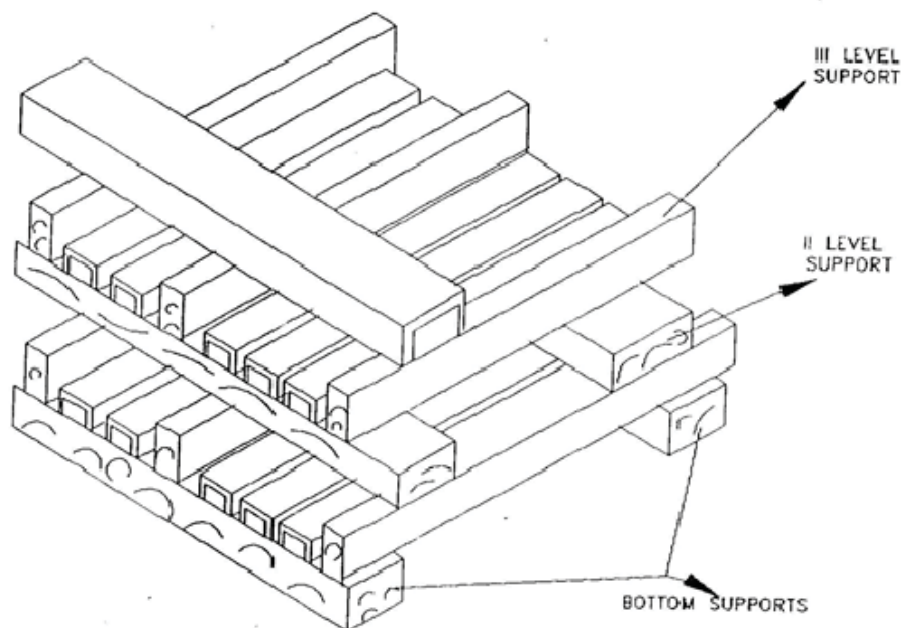


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

 PSSR-QUALITY SUPPLIER'S NAME & ADDRESS		STANDARD FIELD QUALITY PLAN						
		SYSTEM : EOT Crane		QP NO. : REV. No. : 00 PAGE No.: 1 of 4			REMARKS	
		AREA : D/G EOT CRANE UPTO 100 T		CLASS	QUANTUM / FREQUENCY OF CHECK	REFERENCE DOCUMENT/ ACCETANCE STANDARD		FORMAT OF RECORD
SL.NO.	CHARACTERISTICS / ITEM	TYPE OF CHECK	INSTRUMENT					
1	RECEIPT & STORAGE EOT Crane after arrival at site. a. Check manufacturers dispatch documents at site, MDCC, CHP etc. for completeness, identification. b. Check for coating condition of rust inhibitor check and any transit damage c. Storage condition of parts, rails, crane girders and structural parts shall be placed on the elevated surface. * Gear box, fasteners and wire ropes shall be stored in closed covered shed.	Record Verification	Visual	B	100%	Drawings / Tech. Spec.	Protocol	
		Visual	Visual	B	100%	Drawings/Tech. Spec/No. Damage	Protocol	
		Physical	Visual	B	100%	Storage & Preservation Procedure.	Protocol	
		Physical	Visual	B	100%	Storage & Preservation Manual	Protocol	
2	PRE-ERECTION CHECK a. For Gantry at every 5.0 M i.e. span, level, diagonals before taking over from Client b. Web axes of gantry girders in a raw are aligned. c. Center to center distance of gantry girders.	Measurement	Tape, Water level	A	100%	Drawings	Protocol	
		Measurement	Water level	B	100%	Drawings/ER Manual	Protocol	
		Measurement	Measuring Tape	B	100%	Drawings/ER Manual	Protocol	
LEGEND : CLASS #:: A = CRITICAL, B = MAJOR, C = MINOR "A" SHALL BE WITNESSED BY BHEL & CUSTOMER/ CLIENT "B" SHALL BE WITNESSED BY BHEL "C" SHALL BE WITNESSED BY ERECTION ENGINEER TYPE @ : V = VISUAL, R = RECORD VERIFICATION, M= MEASUREMENT, P = PHYSICAL & T-TEST		FOR BHEL USE PREPARED BY		FOR BHEL USE REVIEWED AND APPROVED BY		FOR CUSTOMER USE APPROEVD BY		
PART OF SPECIFICATION PE-IS-426-501-A101								

 PPSR-QUALITY		SUPPLIER'S NAME & ADDRESS		STANDARD FIELD QUALITY PLAN				
		SYSTEM : EOT Crane		QP NO. : REV. No. : 00 PAGE No.: 2 of 4			REMARKS	
		AREA : D/G EOT CRANE UPTO 100 T						
SL.NO.	CHARACTERISTICS / ITEM	TYPE OF CHECK	INSTRUMENT	CLASS	QUANTUM / FREQUENCY OF CHECK	REFERENCE DOCUMENT/ ACCETANCE STANDARD	FORMAT OF RECORD	
3	Check for Alignment of Rails							
	a. Straightness of gantry rails	Measurement	Piano Wire/ Twine	B	100%	Drawings/Erection Manual	Protocol	
	b. Level and Elevation of Gantry rails (top level of girder)	Measurement	Water level/ Measuring Tape	A	100%	Drawings/Erection Manual	Protocol	
	c. Distance between rails(every 5 M) (Tolerance.±. 6mm) including diagonal of gantry rails (Tolerance±. 5 mm)	Measurement	Measuring Tape	A	100%	Drawings/Erection Manual	Protocol	
	d. Bolting of rails and tightening	Measurement	Torque wrench	C	100%	Drawings	Protocol	
4	e. End Stopper Arrangement	Physical	-	A	100%	Drawing	Protocol	
	ERECTION CHECK FOR							
	a. Joining of Girders i.e. splice joints	Physical	-	B	100%	Tech. Spec.	Protocol	
	b. Placement of girder assembly on the gantry.	Physical	-	B	100%	Drawings/Tech Spec.	Protocol	
	c. Movement of wheels	Physical	-	B	100%	Drawings/Tech Spec.	Protocol	
d. Placement and positioning of electrical panel & trolley.	Physical	-	B	100%	Drawings/Tech Spec.	Protocol		

Page 3

LEGEND : CLASS #:: A = CRITICAL, B = MAJOR, C = MINOR
"A" SHALL BE WITNESSED BY BHEL & CUSTOMER/ CLIENT
"B" SHALL BE WITNESSED BY BHEL
"C" SHALL BE WITNESSED BY ERECTION ENGINEER
TYPE @ : V = VISUAL, R = RECORD VERIFICATION,
M= MEASUREMENT, P = PHYSICAL & T-TEST
PART OF SPECIFICATION PE-IS-426-501-A101

FOR BHEL USE

FOR BHEL USE

FOR CUSTOMER USE

PREPARED BY	REVIEWED AND APPROVED BY	APPROVED BY

 PSSR-QUALITY SUPPLIER'S NAME & ADDRESS		STANDARD FIELD QUALITY PLAN						
		SYSTEM : EOT Crane		QP NO. : REV. No. : 00 PAGE No.: 3 of 4				
		AREA : D/G EOT CRANE UPTO 100 T						
SL.NO.	CHARACTERISTICS / ITEM	TYPE OF CHECK	INSTRUMENT	CLASS	QUANTUM / FREQUENCY OF CHECK	REFERENCE DOCUMENT/ ACCETANCE STANDARD	FORMAT OF RECORD	REMARKS
5	e. Movement of crab trolley on the crane girder f. Deviation in the crane rail level at any point from true level tolerance $\pm$ 10 mm D.S.L. a. Fixing arrangement b. Location with respect to gantry rail, spacing & alignment. c. Continuity check & insulation Resistance	Physical Measurement Visual Measurement Measurement Physical Visual & Measurement Measurement	- Piano Wire / Twince - Measuring Tape Megger - Measuring Tape Dip stick	B A C B A B B B	100% 100% 100% 100% 100% 100% 100%	Drawings/Tech Spec. Drawings/ Erection Manual Drawing Drawing Minimum 5 Mega Ohms Drawing Drawing Drawing	Protocol Protocol Protocol Protocol Protocol Protocol Site log Book Protocol Protocol Protocol	
6 7 8 9 10 11	Cable laying connections Crab Clearances a. Headroom, end clearance, hook approaches and height of lift and record. Gear Box a.Check oil level LT Machinery, Platform, cabin, Electrical equipment, other structural components, limit switch & Mechanical stopper. a. Fit up b. Alignment Storm braker arrangement COMMISSIONING CHECKS							
LEGEND : CLASS #:: A = CRITICAL, B = MAJOR, C = MINOR "A" SHALL BE WITNESSED BY BHEL & CUSTOMER/ CLIENT "B" SHALL BE WITNESSED BY BHEL "C" SHALL BE WITNESSED BY ERECTION ENGINEER		FOR BHEL USE		FOR BHEL USE		FOR CUSTOMER USE		
TYPE @ : V = VISUAL, M= MEASUREMENT, R = RECORD VERIFICATION, & T-TEST		PREPARED BY		REVIEWED AND APPROVED BY		APPROEVD BY		
				PART OF SPECIFICATION PE-IS-426-501-A101				

SUPPLIER'S NAME & ADDRESS		STANDARD FIELD QUALITY PLAN						
		SYSTEM		: EOT Crane		QP NO. : REV. No. : 00 PAGE No. : 4 of 4		REMARKS
		AREA		: D/G EOT CRANE UPTO 100 T				
SL.NO.	CHARACTERISTICS / ITEM	TYPE OF CHECK	INSTRUMENT	CLASS	QUANTUM / FREQUENCY OF CHECK	REFERENCE DOCUMENT/ ACCETANCE STANDARD	FORMAT OF RECORD	
	a. Power & control cable connections Insulation Resistance	Visual	Megger	A	100%	Min 5 Mega Ohms	Protocol	
	b. Control panel earthing Insulation resistance Function & sequential operation	Measurement Physical	Megger	A B	100%	Min 5 Mega Ohms	Protocol	
	c. Resistance box earthing IR value	Measurement	-	B	100%	Min 5 Mega Ohms	Protocol	
	Resistance	Measurement	-	B	100%	Drawing	Protocol	
	d. Operation of Brakes (Hoist motion, L.T. Motion & C.T. motion)	Physical	-	A	100%	O&M Manual	Protocol	
	e. Operation of limit Switch (Hoist & traveling motion brakes)	Physical	-	A	100%	O&M Manual	Protocol	
	f. Motors. IR value	Measurement	-	B	100%	Min 5 Mega Ohms	Protocol	
	Earthing							
	g. At no load check Motor Current Crane Speed (only watching all motion)	Measurement Measurement	-	A A	100% 100%	As per procedure	Protocol	
	h. At full load check / Load testing of crane (SWL): Motor Current Crane Speed Deflection.	Measurement Measurement Measurement		A A A	100% 100% 100%	As per procedure	Protocol	
	i. At 25% Overload (only watching all motion)	Visual	-	A	100%	As per procedure	Protocol	
	j. Storm braker arrangement	Physical	-	A	100%	As per procedure Drawing	Protocol	
	k. Touch Up Painting.	Visual	-	C		As per approved shade	Records	
Page 3								
LEGEND : CLASS #:: A = CRITICAL, B = MAJOR, C = MINOR		FOR BHEL USE		FOR BHEL USE		FOR CUSTOMER USE		
"A" SHALL BE WITNESSED BY BHEL & CUSTOMER/ CLIENT								
"B" SHALL BE WITNESSED BY BHEL								
"C" SHALL BE WITNESSED BY ERECTION ENGINEER								
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TYPE @ : V = VISUAL, R = RECORD VERIFICATION, M= MEASUREMENT, P = PHYSICAL & T-TEST		PREPARED BY		REVIEWED AND APPROVED BY	
PART OF SPECIFICATION PE-IS-426-501-A101				APPROEVD BY	



**TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN**

SPECIFICATION No: PE-TS-426-501-A101

PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)

SECTION-I

REV. 00

Check List for Operation & Maintenance Manual

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

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



**TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN**

SPECIFICATION No: PE-TS-426-501-A101

PACKAGE: DOUBLE GIRDER EOT CRANE (UPTO 100T)

SECTION-I

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4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	Operation Guidelines for plant personal/user/operator				
5.1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5.2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5.3	Do's & Don't of the equipments.				
5.4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5.5	Parameters to be monitored with normal values and limiting values				
5.6	Trouble shooting with causes and remedial measures				
5.7	Routine operational checks, recommended logs & records				
5.8	Changeover schedule if more than one auxiliary for the same purpose is given				
5.9	Painting requirement and schedule				
5.10	Inspection, repair , Testing and calibration procedures				
6.0	Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning,				



TECHNICAL SPECIFICATION
FOR
1X660 MW PANKI EXTN

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

Checked by
 Dealing Engineer

Key Resource Person

Section Head



**TECHNICAL SPECIFICATION
FOR
D/G EOT CRANE UPTO 100T
1X660 MW UPRVUNL PANKI TPS EXTN.**

SPEC. NO.: PE-TS-426-501-A101

SECTION: III

REV. NO. **0** DATE

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SECTION III

PART OF SPECIFICATION PE-TS-426-501-A101



**TECHNICAL SPECIFICATION
FOR
D/G EOT CRANE UPTO 100T
1X660 MW UPRVUNL PANKI TPS EXTN.**

SPEC. NO.: PE-TS-426-501-A101

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DRAWINGS / DOCUMENTS TO BE SUBMITTED WITH THE BID

Bidder shall submit the following drawings / documents along with their bid-

- a. Signed and Stamped copy of Compliance cum Confirmation Certificate
- b. **Deviation schedule** with reference to **specific clauses of the specification** along with reason **and cost of withdrawal** for such deviation in the “DEVIATION SHEET (COST OF WITHDRAWAL)” format attached in the tender
OR
No Deviation Certificate in the “DEVIATION SHEET (COST OF WITHDRAWAL)” format attached in the tender
- c. Un priced copy of price format indicating quoted/ not applicable against each row/column

OFFER WILL BE CONSIDERED AS INCOMPLETE IN ABSENCE OF ANY OF ABOVE DOCUMENTS. DOCUMENT OTHER THAN ABOVE, IF ANY, SUBMITTED WITH THE OFFER WILL NOT FORM PART OF CONTRACT AND ACCORDINGLY WILL NOT BE CONSIDERED FOR BID EVALUATION.

PART OF SPECIFICATION PE-TS-426-501-A101



TECHNICAL SPECIFICATION
FOR
D/G EOT CRANE UPTO 100T
1X660 MW UPRVUNL PANKI TPS EXTN.

SPECIFICATION NO. PE-TS-426-501-A101

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PRE-BID CLARIFICATION SCHEDULE

[illegible]

The bidder hereby certifies that above mentioned are the only clarifications required on the technical specification for the subject package.

SIGNATURE: _____

NAME: _____

DESIGNATION: _____

COMPANY: _____

DATE: _____

COMPANY SEAL

		DEVIATION SHEET (COST OF WITHDRAWAL)							
		PROJECT:-1X660 MW UPRVUNL PANKI TPS EXTN.							
		PACKAGE:- DOUBLE GIRDER FOT CRANES (UPTO 100T)							
		TENDER ENQUIRY REFERENCE:-							
SPECIFICATION NO PE-TS-426-501-A101								VOLUME III	
NAME OF VENDOR:-									
SL NO	VOULME/SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION / TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF WITHDRAWL OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRAWL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
		In case of no deviation, the same is to be mentioned here. Otherwise, clause wise devaitons along with cost of withdrawal of deviation, if applicable shall be furnished in sealed envelope along with Original price bid. However, the same shall be indicated as 'Quoted' under column 'Cost of Withdrawal of Deviation' along with technical offer/ un-priced bid.							
COMMERCIAL DEVIATIONS									
PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE									
NAME				DESIGNATIONS			SIGN & DATE		
NOTES:									
1. For self manufactured items of bidder, cost of withdrawl of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.									
2. For directly dispatchable items, cost of withdrawl of deviation will be applicable on the basic price including taxes, duties & freight.									
3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.									
4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.									
5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawl of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.									
6. Bidder shall furnish price copy of above format along with price bid.									
7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.									
8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.									
9. For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawl of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format.									
10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.									
11. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.									
12. Cost of withdrawl is to be given seperately for each deviation. In no event bidder should club cost of withdrawl of more than one deviation else cost of withdrawl of such deviations which have been clubbed together shall be considered as NIL.									
13. In case nature of cost of withdrawl (positive/negative) is not specified it shall be assumed as positive.									
14. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.									

PART OF SPECIFICATION PE-TS-426-501-A101



TITLE:

1X660 MW UPRVUNL PANKI TPS EXTN.

SPEC. NO.: PE-TS-426-501-A101

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SHEET 1 OF 2

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

- a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', with regard to same.
- b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'
- c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.
- d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.
- e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.
- f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.
- g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.
- h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions
- i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account
- j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
- k) As built drawings shall be submitted as and when required during the project execution.

PART OF SPECIFICATION PE-TS-426-501-A101



TITLE:

1X660 MW UPRVUNL PANKI TPS EXTN.

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- 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) Regarding commercial documents / deviations, BHEL clarified that commercial documents / deviations shall not been considered during technical evaluation. However if any issue in the commercial documents / deviation related to technical requirements needs to be highlighted and resolve in technical evaluation only. No aspect of commercial issues needs to be highlighted / resolved in technical evaluation and their offer is strictly in compliance with technical specification. BHEL also clarified to the bidder any technical deviations (e.g. related to MDL, required documentation etc. for completion of the project) raised by them in commercial deviation either explicit or implicit shall be considered null and void even if agreed by BHEL during commercial evaluation stage. Bidder agreed to confirm and compliance with technical specification and subsequent clarification on bids during pre- award discussion.

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