BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TYPE OF DOC.	**TECHNICAL SECIFICATION**			**NAME**	**AJ**	**TDT**	**SKS**
TITLE						
10T DOUBLE GIRDER EOT CRANE (400KV-Gas Insulated Switchyard)				**DATE**	**24.11.21**	**24.11.21**	**24.11.21**
				GROUP	**TBEM**	Job No.	**405**
CUSTOMER	**SJVN ARUN-III POWER DEVELOPMENT COMPANY (P) LTD. (SAPDC)**					
CONSULTANT	**SJVN LTD.**					
PROJECT	**4x225MW ARUN-III, HYDRO ELECTRIC PROJECT, NEPAL**					

विषय-सूचि /CONTENTS

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS

SECTION-1
INTENT, SYSTEM REQUIREMENT, DESIGN CRITERIA & SCOPE

1.0 INTENT OF SPECIFICATION

1.0.0 **This specification is intended to cover following activities and services in respect of all the equipment of the One Set Double Girder EOT Crane of 10T capacity** to be provided for 400 kV Gas Insulated Substation Building of **4X225MW ARUN-III, HEP.**

i) **Detailed design and engineering of all the equipment and equipment system(s).**
ii) **Complete manufacturing including shop testing.**
iii) **Providing engineering data, drawings, and O & M manuals as per specified format etc. for owner's/purchaser's review, approval and records.**
iv) **Packing and transportation from the manufacturer's works to the destination (as per NIT) including any clearance, if required.**
v) **Fabrication, pre-assembly, if any, erection testing and putting into satisfactory operation all the equipment including successful completion of trial operation.**
vi) **Performance and Guarantee tests after successful completion of trial operation, Training of Personal, Handing over and Warrantee for two years of EOT Crane.**

Note: Receipt of material and safe storage of all components shall be excluded from bidder's scope.

1.0.1 The requirements specified under SECTION 2, SECTION 3 & SECTION 4 of the specification shall be considered as part of this section. In the event of any conflict between the various sections/sub-sections of this specification, SECTION 1 shall prevail.

1.0.2 It is not the intent to specify herein all the details of design and manufacture. However, the equipment and the system 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/ Owner, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance herewith.

1.0.3 This specification shall be read in conjunction with all its enclosures. In case of any discrepancy arising between this job specification & its enclosures, the most stringent of all (as determined by purchaser) shall be followed. In all cases, end customer's specification requirement enclosed in various annexures shall be adhered to.

Further, if a requirement in this specification or any of the enclosures, calls for a decision from the Purchaser, it shall be bidder's sole responsibility to clearly bring out/highlight the same distinctively in his pre-bid queries, so as to enable purchaser to furnish their decision/clarification. If such issues/requirements are not duly addressed by bidder during the pre-bid stage and if such issues/requirements have been observed later during order execution stage, it shall be binding on the bidder to comply with the final decision made by the purchaser subsequently, without any cost, delivery, or any other commercial implications.

1.0.4 Contract shall be on unit rate basis for the for the quantities and scope defined in the specification. The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of ensuring operability, maintainability and the reliability of the complete work covered under this specification. Variations in quantities during contract stage without any change in input from BHEL side shall not have any commercial

implications. BHEL reserves the right for quantity variation (upward/ downward) due to any reason upto ±20% of total contract value at same unit rate and terms & conditions during execution of contract.

1.0.5 The Bidder shall deem to have understood completely all the tender drawings and documents and quoted accordingly.

1.0.6 **Deviation:** There shall preferably be no deviation on technical specification. The bidder shall sign and stamp the "Certificate for No Deviation" enclosed in Schedule-2, Section-4 towards confirmation. Except for these deviations/ variations covered under Deviation Schedules which are accepted by the Purchaser before the award of the Contract, it will be the responsibility of the Bidder to fully meet the intent and the requirements of the specification within the quoted price. *Deviations in any other form including clarifications / assumptions / etc will not be considered and it will be construed that the bid conforms strictly to the specification*.

1.0.7 The Bidder to note carefully that the parameters, estimated capacities of equipment indicated and the tender drawings in the specification are only for the guidance of the Bidder. The system shall be designed as per relevant standards/ codes and exact capacities and quantities are to be estimated by the Bidder. All such estimations and design calculations shall be submitted for Purchaser's approval.

1.0.8 It is the responsibility of the successful Bidder to obtain necessary approval/ clearance from statutory organizations wherever applicable for the equipment/ systems under the scope specified.

1.0.9 The term **'Owner/Client'** appearing in this specification shall refer to **SJVN Arun-III Power Development Company (P) Ltd. (SAPDC)**, the term **'Consultant'** shall refer to **SJVN ARUN POWER DEVELOPMENT COMPANY LTD. (SAPDC LTD.)**, the term **'Purchaser'** shall refer to **BHEL** and the term **'Contractor'** shall refer to the **successful Bidder**.

This system shall be designed to provide one no. 10T capacity Double Girder EOT Crane for GIS Hall Building of **4X225MW ARUN-III, HEP -400 KV GIS.**

2.0 Scope

One number (1) Double Girder Electrically Operated Travelling Crane or EOT Crane **(having 10 tones capacity)** with Variable Voltage Variable Frequency i.e. VVVF Drive in all three controls of Hoisting, CT & LT suitable for erection of various equipment at 400 kV GIS Hall Building shall be required.

Crane shall be designed on the following main technical parameters:

S.N	Description	Technical Particulars
1.	GENERAL	Double Girder EOT Crane at 400KV GIS Hall Building
2.	Type of Crane	Double Girder EOT
3.	Capacity (SWC)	10 Tones
4.	Span*	12.2 m
5.1	Lift	8 m
5.2	Bay Length*	72 m
6.	Crane structure	Double Girder

7.	PAINTING	As per Annexure-II of this spec.
8.	Control for Hoisting, CT and LT operations	Thru' VVVF drives
9.	Speed Control	Thru' VVVF drive
10.	Design Temperature	40 degC

Please refer Layout of GIS hall Building attached to this specification for exact dimension. Minimum margin of +/-10% should be considered for bidding purpose.
Reference: Layout of GIS Building of 4x225MW Arun-3 HEP (TB-3-405-316-020 Rev.03)

Scope shall include design, engineering, manufacture, assembly/pre-assembly, tests at manufacturer's works, shop painting & packing and transportation to site of the equipment complete with all the auxiliaries as specified hereunder for trouble free and satisfactory operation.

2.1 SCOPE OF SUPPLY AND SERVICES

The scope of the work under the contract shall be deemed to include all such items, which although not specifically mentioned in the bid documents and/or in the bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble-free operation, unless the same is specifically excluded from the bidder's scope of work under clause 7.0 of this section. The scope covers broadly the following:

A. SUPPLIES

Equipment and services to be furnished by the bidder for the Double Girder EOT Crane with accessories as per the details given in data sheet. Any equipment / accessories not specified in the specification but required to make the crane units complete and efficient shall also be under the bidder's scope of work.

Each EOT crane shall include all necessary items but shall not be limited to the following:

i. Bridge girder.
ii. Maintenance platform
iii. End carriages complete with wheels
iv. Electric Hoist (For EOT Crane)
v. CT / L T drive arrangement
vi. Electrical equipment
vii. PVC Shrouded Conductor Bus Bar Type DSL with accessories for entire bay length.
viii. Earthing arrangement.
ix. First fill of lubricant.
x. Main isolating switch and power cable from 1.5 m above ground / operating floor to down shop lead.

B. Services to be provided by the bidder

1. Packing, loading, transportation to site.

2. Erection, testing and commissioning at site.

3. Arranging test load at site: Collecting the test load at site within a radius of 3 KM from 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.

4. Operation & maintenance.

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

C. Inspection and Testing

Inspection and testing at Manufacturer's works

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

i. Identification, co-relation and verification of material test certificates for the important components like girders, major load carrying components, hooks, gears, shafts, wheels, wire, rope drum, wire rope etc. For other components supporting test certificates or random check tests shall be conducted.

ii. Qualification of welder and welding procedure as per ASME section 1X of ASTM -7.1.

iii. 100% radiography of tension zone & 25% radiography of compression butt welds of load bearing members shall be carried over and all butt welds as per ASME- 165/ASTME 109 and acceptance norm as per ASME Section viii Div.1.

iv. For fillet welds visual inspection on all welds. Die penetration test (DPT) for fillet welds in the load bearing members as per ASME-165/ASTME 109 and acceptance norm as per ASME section VIII Div. 1.

v. Ultrasonic test on forgings and casting of critical components like hook, shafts, axles, gears, wheels, pulleys, etc. Ultrasonic test for casting as per ASME Section III NB 2572 & for forging as per ASTM A388.

vi. Unacceptable defects in forgings are as given below: -

   a. Cracks, flaws, seams and laps.

   b. Defects giving indication larger than 4mm diameter equivalent flaw.

   c. Groups of defects with maximum indication less than that from a 4mm dia, equivalent flaw, which cannot be separated at testing sensitivity if the back echo is reduced by 50%.

   d. Defects giving indication of 2 to 4 mm diameter equivalent flaw separated by a distance less than 4 the size of the larger of the adjacent flaws.

vii. PT/ MT on component with surface hardening as per ASTME -165 and ASTME 138 respectively with no surface defects.

viii. Gearbox trial run test as per AGMA standards.

ix. Verification of type test certificates and enclosure for electrical and electro mechanical items. If type test certificates of the similar items are not available, arrangement shall be made to conduct the same in the presence of BHEL/ Customers representative.

x. Acceptance and routine tests (HV and insulation) for all electrical and electromechanical components and system as per governing specification

xi. Functional and simulated operation test, sequencing, interlocks, safety, protection and alarm system. Test on CRANE/ CRAB motors and other mechanical, electrical, electro-mechanical as per BHEL technical specification and or as per applicable code

xii. Cranes shall be completely assembled at manufacturer's works to check the misalignment of gears, shafts and other items. Gears shall have the idle run for minimum two (2) hours.

Testing At Works

i. Deflection test of bridge girder at rated load

ii. No load / load (EWL) / Over load test (running of CT & Hoisting mechanism at 125% of rated load.)
iii. Electrical tests for brakes, panel, electrical equipment etc. as per IS - 3177
iv. No load run test of LT mechanism
v. Measurement of speed of CT & Hoisting (lowering & raising) at rated load
vi. All Other tests as per IS - 3177.
vii. All Tests including Proof Load Test as per relevant IS shall be carried out for Hooks
viii. MPI/DPT shall be carried out after proof load test.
ix. DPT on machined surface shall be carried out for steel casting
x. 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	100% RT and 100% DPT
d)	Fillet Welds	Random 10% DPT

FORGINGS (wheel, gears, pinions, axle, hooks & hook trunion).

All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to Ultrasonic test. PT/MPI shall be done after hard facing and machining.

xi. Wire rope shall be tested as per relevant standard.
xii. 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.
xiii. 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.

Testing at site

Following tests shall be carried out at site as a part of ETC scope:

a) All the tests as mentioned above, with actual hook and wire rope
b) Speed test at rated load for hoisting / CT and LT mechanism
c) Brake test and working of both electric hoist
d) Any other test as per IS-3177-1999.

The successful bidder shall furnish their recommended procedure for carrying out the Erection and Commissioning, to be done by the customer.

2.2 Drawing / design document for submission.

All applicable documents, drawings and datasheets as per below list to be submitted during detailed engineering.

A. For Approval

a) G.A. drawing showing clearances, assembly, cross section details, materials of construction, lifts and hook approach.
b) Hoist assembly.
c) DSL fixing arrangement and supports
d) Motors HP/KW calculations, brake selection calculation, cable sizing calculations, voltages drop calculation etc.

e) Gantry Rail fixing Arrangement with accessories. (If applicable)
f) Write up on the crane control.
g) Wire rope selection, gearbox selection, rope drum selection and wheel size selection calculation
h) Electrical wiring diagram and control scheme
i) Quality Plan.
j) Test certificates and reports on various shop tests.
k) Field quality plans.
l) O.M. Manuals
m) Technical data sheet of all equipment / components

B. <u>For Reference</u>

a) Hook block assy. And gear box drawings.
b) Rope drum assy. drg.
c) Cross conductor on bridge.
d) Crane lubrication arrangement
e) LT & CT wheel Assembly drawing
f) Manufacturers catalog
g) Motor characteristics curves.
h) Structural Calculation
i) Detailed erection drawing (as erection shall be carried by customer himself complete erection procedure, literature and necessary erection drawing shall be provided).

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

3.0 Design Features & requirements

CODES AND STANDARDS.

The design, manufacture and testing of the crane shall conform to the latest editions of the codes and standards as given below.

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: 325	Three phase induction motors.
vii)	IS: 900	Code of practice for installation and maintenance of induction motors.

viii)	IS: 4237	General requirement of switchgear and Control gear for voltage not exceeding 1000V.
ix)	IS: 434 (Part I)	Copper conductors rubber insulated cables for voltage up to 1000V.
x)	IS 1596	Polyethylene insulated PVC sheathed cables
xi)	IS 3043	Code of practice Earthing
xii)	IS: 3938	Electric Wire Rope Hoists.
xiii)	IS: 2147	Degree of protection provided by enclosures for Low voltage switchgear and control gear.
xiv)	IS: 1554 Part I	PVC insulated (Heavy-duty) electric cables for working voltages up to and including 1100 volts.
xv)	IS: 691	Flexible trailing cables rubber insulated.
xvi)	IS: 1653	Steel conduits for general engineering purposes.
xvii)	IS: 2509	Rigid non-metallic conduit for electric Installations
xviii)	IS: 2062	Steel for General Engineering purposes.
xix)	IS: 1030	Carbon Steel castings for general engineering purposes.
xx)	IS: 1570	Schedules for Wrought steels.
xxi)	IS: 1875	Carbon steel billets, blooms, slabs and bars for forgings.
xxii)	IS: 808	Dimensions for hot rolled steel beam, column, channel and angle sections.
xxiii)	IS: 1852	Rolling and cutting tolerances for Hot rolled steel products.
xxiv)	IS: 2291	Tangential Keys and Keyways.
xxv)	IS: 2292	Taper Keys and Keyways.
xxvi)	IS: 3961	Recommended current rating for cables.
xxvii)	IS: 694	PVC insulated cables for working voltages up to and including 1100V)
xxviii)	IS: 1554 (part-I)	PVC insulated (heavy duty) electric cables: Part 1: for working voltages up to and including 1100 volts.

xxix)	IS: 4289	Flexible cables for lifts and other flexible connections: Part 1: Elastomer insulated cables.
xxx)	BS: 970	Wrought steels in the form of blooms, billets, bars and forgings.
xxxi)	IS: 5749/ BS 3017	Specification for Forged Rams horn Hooks

3.0.0 **DESIGN REQUIREMENT**

3.1.0 EOT cranes classification conforming to M5 for Mechanical and Electrical as per IS: 3177– (latest edition) will be designed (structural design as per IS 807 - 2006), manufactured, inspected, shop tested, erected, site tested and commissioned to well established engineering practices, safety codes and other relevant codes and standards.

3.2.0 Temperature Effects
Where any portion of the structure is not free to expand or contract under variation of temperature, allowance shall be kept for stress resulting from these conditions. IS: 800- (latest edition) Code of practice for use of structural steel in General Building construction - shall also apply.
Any limitation on above account shall be reported during detail engineering while submitting design calculation of crane components/equipment's/sub system.

3.0.0 Minimum thickness of Metal
For load carrying members the component plates, bars, angles and other rolled sections shall be minimum 6mm thick. For tubes having both ends sealed the minimum thickness shall be 4.9 mm (6 SWG). For unsealed tubes the minimum thickness shall be 8mm. The checkered plates for platforms shall be minimum 6 mm thick.

3.4.0 Safety arrangements such as under voltage and single-phase protection in addition to manufacturer's standard will be provided through VVVF drive to prevent damage to motors on account of mechanical overload and electrical faults and to gearing shafts, etc. due to over stressing.
Protective relays for protection against instantaneous over-current, over-load, single phasing and under voltage for all motors shall be provided. The OC relay to be adjustable between 2 to 3 times the full load motor current.

3.5.0 All materials / components will be new and of tested quality and will conform to the specification requirements and standards mentioned.

3.6.0 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.

3.7.0 Qualified welders as per approved QA plan will carry out welding in accordance with established WPS.

3.8.0 Design will be provided for easy maintenance of all the parts, particularly the wheel bearings on end carriage.

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

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

i. Main Hoist vertical movement 1.5 mm
ii. Bridge Travel 3 mm

iii. Trolley Travel 3 mm

3.11.0 Crane control shall be from Variable Voltage and Variable Frequency (VVVF) drive. Creep speed shall be achieved through VVVF drive for cranes. Refer Annexure-I of this Specification for Technical Specification of VVVF Drives, RRC & DSL.

3.12.0 The cranes and hoist shall be designed to operate at 100% safe working load and subjected to over load test at 125% of rated load.

3.13.0 Design shall be provided for easy maintenance of all the parts.

4.0 CONSTRUCTION FEATURES

4.1.0 The cranes will be furnished with required components comprising the following:

4.1.1 Two individual bridge girders in plate welded box type construction will be fabricated from tested steel plates. Internal diaphragms and ribs will adequately reinforce box section.

4.1.2 Jacking pads will be provided on the structural frames of trolley end carriage, for removal of wheels.

4.1.3 Crane Bridge will be driven by two independent end drives.

4.1.4 Wheelbases for end carriage will as per IS.807 (latest edition).

4.1.5 Brakes for hoist motions shall be designed to suit 150% full load torque (FLT) of the motor and 150% of FLT of CT/LT motors.

4.1.6 PVC shrouded conductor bus bar type Cu DSL will be with suitable guards and service cage for maintenance of DSL will be provided with indication lamps on ends.

4.1.7 Crane shall be complete with trolley, tracks, wheels, axles, drive mechanism, hoisting drum brakes, horns, warning lights limit switches etc.

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

4.1.9 For girders, the following values of maximum span to depth ratio shall be governing:
Plate girders: Span/depth = 18
Lattice girders: Span/depth = 12

4.1.10 Drum will have minimum one spare groove when this hook is at its highest position.

4.1.11 Rope will be of sufficient length so that drum has two full turns when hook is at the lowest position.

4.1.12 RRC and any certification / license from statutory authority required for installation & putting the crane into service shall be arranged by Crane supplier.

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

4.2.0 DEFLECTION AND CAMBER

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

4.3.0 Bridge and Trolley frame

Bridge and trolley frames will be fabricated from steel plates / members. Mounting will be designed to facilitate easy removal of the wheels, bearings and journals. In bridge girder strength calculations, the trolleys, rails and chequered shall not be considered as load carrying members.

4.4.0 Brakes

Brakes shall be of adequate rating to arrest 150 % of the motor full load torque (FLT) for hoisting motion and 150 % of FLT for travel motion.

4.5.0 Drive

All drive motors will be of crane duty conforming to IS: 325 and IS: 3177. The motor shall be suitable for 300 starts / hr. and 40% CDF. Motor nameplate rating at 40^0 C shall have Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement in the duty condition specified.
The motor speed not to exceed 105% of the synchronous speed while lowering the rated load.

4.6.0 Inspection and testing

All material, castings and forgings will be of tested quality.

4.7.0 Control
The control of cranes shall be through VVVF drives.

5.0 Inspection and testing

All material, castings and forgings will be of tested quality & certificates shall be made available as per approved QAP.

Final inspection and load testing of cranes shall be carried out at manufacturer's works. Further the cranes shall also be successfully erected and load testing at site.

Functional Guarantee (at site)

- Load test as per IS 3177(Latest edition)
- Overload test as per IS 3177(Latest edition)
- Operating Speed demonstration.
- Limiting deflection check of bridge girder as per IS 3177 (latest edition)

6.0 Technical Data Sheet of Double Girder EOT Crane

Sr. No.		DESCRIPTION	TECHNICAL PARTICULARS	
1.0.0		**Design, fabrication and testing of the crane confirm to standard / code number**	Mechanical and Electrical as per IS: 3177-1999 (Reaffirmed 2006) & Structure design in accordance to IS 807:2006.	
		*** Make** *** Model** *** Gantry Rail/Monorail Size** *** Weight of complete crane (unladen).** *** Maximum crab weight (unladen).** *** Maximum wheel load (without impact)** *** Drum diameter & length** *** Make of motor** *** Rated current** *** Rated torque (starting/Braking)** *** 15% margin for motor ratings considered**	*(to be furnished by manufacturer)	
1.1.0		**Number of cranes**	01 No.	
1.2.0		**Crane classification**	M5 (Mechanical, Electrical and Structural)	
1.3.0		**Suitable for outdoor or indoor duty**	Indoor	
1.4.0		**Capacity**	10T	
1.4.1		**Main hoist**	SWL = Safe working load	
	a.	Rated SWL – tonnes	*(to be furnished by manufacturer)	
	b.	Test load SWL – tonnes	Rated SWL and over load test : 125% of SWL	
1.4.2		Deflection test of crane	Shall be carried out at SWL	
1.5.0		**Span**	12.2 m	
1.6.0		**Operation from**	Pendant Push button + Radio Remote Control (RRC)	
2.00		**CRANE PERFORMANCE**		
2.1.0		Crane speed with full load	**M/Min**	**Creep speed M/Min**
	a.	Main hoist	**0.16 to 1.6**	5% of operating speed (thru' VVVF drives)
	b.	Trolley travel (CT)	**0.4 to 4**	5% of operating speed (thru' VVVF drives)
	c.	Longitudinal bridge travel (LT)	**0.8 to 8**	5% of operating speed (thru' VVVF drives)
2.2.0		Acceleration values	LT motion (bridge travel)	CT motion (trolley travel)
			0.2 m/sec^2	0.2 m/sec^2
2.3.0		**Lift in Metres**	The lifting rope shall be of sufficient length to permit the main hook to reach the zero level.	
	a.	Main Hoist	8 m	
2.4.0		**Hook Approaches**		
	a.	Main hook (DSL end)	To suit the layout requirement.	

	b.	Main hook (Other end)			
2.5.0		Hand Rail Pipes	32 mm NB Medium class of IS: 1239 having top and bottom rail at height of 1000 mm and 500 mm and vertical post spacing not exceeding 1100 mm as far as possible but can be adjusted to suit the length of railing with provision of kick plate (100 mm high and 6mm thick)		
3.0.0		**COMPONENT DETAILS**			
3.1.0		**Trolley**			
	a.	***Type***	***Fabricated/ Fusion welded***		
	b.	***Material***	***MS. IS: 2062 Gr. A or B***		
	c.	***Number of Trolleys***	***One (1)***		
	d.	***Number of hoists on trolley***	***One (1) Main***		
3.2.0		**Rope drums**			
	a.	Type	Rope drums shall be spur / helical gear type and should be fabricated from M.S. as per IS 2062 and should be stress relieved.		
	b.	Material	Seamless pipe ASTM-106 or fabricated Fe410w IS: 2062 Gr. A/B & stress relieved.		
	c.	Flange / flangeless	Flanged		
	d.	Numbers provided	One for each hoist		
	e.	Type of grooves	Machined grooved identical Right hand and Left hand		
	f.	Other requirements	a) Drum will have minimum one spare groove when this hook is at its highest position. b) Rope will be of sufficient length so that drum has two full turns when hook is at the lowest position.		
3.3.0		**Rope details**			
	a.	Standard	IS:2266		
	b.	Construction	6 x 36 or equivalent		
	d.	Factor of safety	6		
	e.	Type of core	Steel		
	f.	Grade	1770/1960		
3.4.0		**Sheaves details**			
	a.	Material	Fe 410 WA IS: 2062 Gr. A or B 1 CS Gr. 280-520 IS: 1030 Design as per IS: 3177- 1999		
	b.	Diameter of Equivalent sheaves in mm on Root	Should not be less than 62% of calculated main sheave diameter.		
	c.	Type of guards provided	Fabricated from rolled steel plate		
	d.	Other Requirements	1. Shall be machine grooved to a depth of not less than 1.5 (one and one half) times the diameter of the rope. 2. Guards shall be provided to retain the rope in grooves.		
3.5.0		**Coupling & Shafting**			
3.5.1	**A.**	**Coupling details (between motor and gear box)**	**Main Hoist**	**Cross Travel**	**Long Travel**
	a.	Type	Flexible shock absorbing coupling excepting pin bush type		
	b.	Guards and Enclosures	Provided		
	B.	**Coupling details (gear box and**	**Cross Travel**	**Long Travel**	

		wheels)		
	a.	Type	Flexible geared type	
	b.	Guards and Enclosures	Provided	
	C.	**Coupling details (gear box and rope drum)**	**Main Hoist**	
	a.	Type	One of the following arrangements will be adopted for connecting the rope drum with the gear- box. 1. Flexible joint, incorporating flexible geared coupling housed within the drum. 2. Fully flexible geared coupling between the drum & gearbox.	
	b.	Guards and Enclosures	Provided	
3.5.2	**A.**	**Shafting (Output)**		
	a.	Factor of Safety	As per IS : 3177 - 1999	
	b.	Arrangement of Lubrication	Grease cups/ Nipples	
	c.	Type of Lubricant	Grease	
3.6.0		**Gear box details**		
3.6.1		**Hoist Motions**		
	a.	Type of mounting of gear box	Horizontal / Vertical	
	b.	Classification	Suitable for M5 duty	
	c.	Type of gears	Helical / Spur	
	d.	Type of lubrication	Splash lubrication	
	e.	Difference in Gear and pinion hardness	Min 20 BHN	
	f.	Materials (gear/pinions)	Main Gears En 9/ 55C8/ IS2707 Gr. 1 or 2 Pinions En 19/EN 24. Hardness conforming to IS: 3177 (latest edition) Gears to be hardened, tempered & heat treated as per IS 4460 OR Hardened and ground gears & pinions. Material (gear/pinions) - 815M17/En353. The hardness of gears & pinions shall be in the range of 560-580BHN.	
	g.	Casings	Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved	
	h.	Type of Bearing	Antifriction Ball/ roller	
3.6.2		**Travel Motions**	**CT**	**LT**
	a.	Type of mounting gear box	Vertical / Horizontal	Vertical / Horizontal
	b.	Classification	M5 duty	
	c.	Type of gears	Helical / spur	
	d.	Type of lubrication	Splash lubrication	
	e.	Difference in Gear and pinion hardness	Min 20 BHN	
	f.	Materials (gear / pinions)	Main Gears En 9/ 55C8/ IS2707 Gr. 1 or 2 Pinions En 19/EN 24. Hardness conforming to IS: 3177 (latest edition) OR Hardened and ground gears & pinions. Material (gear/pinions) - 815M17/En353. The hardness of gears & pinions shall be in the range of 560 - 580BHN.	

	g.	Casings	Fabricated Fe 410w IS: 2062 Gr A/B & stress relieved	
	h.	Type of Bearing	Antifriction Ball/ roller	
3.7.0		**Wheels details**	**Cross travel**	**Long travel**
	a.	Material	C55 MN-75	
	c.	Type	Double flanged	
	d.	Numbers provided	As per manufacturer's standard.	
	e.	Hardness	300 - 350 BHN	
	f.	Arrangement of lubrication	Grease	
	g.	Specification conforming to	IS: 3177 (latest edition)	
	h.	Other requirement	Bridge and trolley wheels shall be identical for interchangeability.	
3.8.0		**Lifting hooks**		
	a.	Type	Shank type with safety latch swiveling type as per latest edition of IS 15560	
	b.	Safe lifting capacity	*(to be furnished by manufacturer)	
	c.	Material	Class 2 as per IS 1875: 1992 (re affirmed 2004) for hooks conforming to IS : 5749 Class 1A and class 3 steels of IS 1875 for hook of grades L & M respectively as per IS 1875:1992 for hooks conforming to IS : 15560	
	d.	Standard conforming to	IS 15560	
	e.	Hook can swivel	Yes	
	f.	Safety latch on hook provided	Yes	
	g.	Other requirement	Protective skirt shall be provided to enclose the bearings	
3.9.0		**Buffers**	**Cross travel**	**Long travel**
	a.	Type	Spring or rubber buffer. To be designed to bring the loaded crane to rest from speed of 50% of the rated speed.	
	b.	Numbers provided	4	4
3.10.0		**Brakes**		
3.10.1		**Hoist Motions**		
	a	Type of brake	Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro-magnetic (double brake disc type)	
	b.	Number provided per motor	1+1	
	c.	Braking capacity (% of full load torque)	150%	
3.10.2		**Travel Motions**	**CT**	**LT**
	a.	Type of brake	Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro-magnetic (double brake disc type)	Automatic AC Electro-Hydraulic Thruster operated + Automatic DC electro-magnetic (double brake disc type)
	b.	Number provided per motor	1+1	1+1
	c.	Braking capacity (% of full load torque)	150%	150%
	d.	Other requirements	The brakes system shall have the following provisions:-	

			a) Locking device in the brake lever. b) Means for adjustment to compensate for wear of the shoes. c) Emergency stop push buttons.				
	e.	Holding Clamps Against Earthquake	Shall be provided for all cranes to withstand seismic events and earthquake				
3.11.0		**Drive system for hoisting**					
	a.	Arrangement of drive from motor to rope drum (main)	Through geared steel coupling and gear box				
3.12.0		**Bearings**	**Crane hook**	**Trolley wheels**	**Rope drum**	**Gear box**	**Any other assembly**
	a.	Type	Antifriction ball / roller bearings				
	b.	Lubrication	Grease lubrication				
	c.	Bearing life	10,000 working hours.				
3.13.0		**Bridge girder**					
	a.	Type & Quantity	Box type – 2 nos., Material: IS 2062 Gr. A / B				
	b.	Vertical Deflection	The total maximum vertical deflections for the girder for the safe weight of working load plus the weight of crab in central position (Without taking into consideration the impact factor) will not exceed limit of span/750 for crane (if span of the cranes is more than 12m), and span/600 for crane (if span of the cranes is less than 12m) as per IS 807.				
	c.	Type of connection to end carriage	By fitted bolts				
	d.	Other requirements	The swiveling hook shall be of forged steel and mounted on ball thrust bearings. Protective skirt shall be provided to enclose the bearings				
		Rails-Bridge Girder					
	a.	Type / section	50x50mm Square				
	b.	Standard conforming to	As per relevant standard				
	c.	Material	MS				
	d.	Rail	50mm square Bar				
3.14.0		**Motors**	Suitable for design ambient temperature of 40° C				
3.14.1		**Hoist Motions**	**MH**				
	a.	Type	SC, suitable for Inverter duty				
	b.	Enclosure	TEFC				
	c.	Numbers furnished	1				
	d.	Voltage, phase and frequency	3 Ph., 4 wire, 415V +/- 10%, 50 Hz +/- 3% Any Combined voltage & frequency variation upto above limits.				
	e.	Class of protection	IP – 54				
	f.	Rated capacity (KW)	The motor shall be suitable for 300 starts / hr and 40% CDF. Motor nameplate rating at 40°C. Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement in the duty condition specified.				

	g.	Duration factor/duty	40 % CDF / S-4		
	h.	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B		
	i.	Number of starts/ hour	300 starts / hr.		
	j.	Pull out torque	The pull out torque of the motor will not be less than 225% of the full load torque at rated voltage and frequency.		
3.14.2		**Travel Motions**	**CT**	**LT**	
	a.	Type	SC, suitable for Inverter duty	SC, suitable for Inverter duty	
	b.	Enclosure	TEFC	TEFC	
	c.	Numbers furnished	1	1	
	d.	Voltage, phase and frequency	3 Ph., 4 wire, 415V +/- 10%, 50 Hz +/- 3% Any Combined voltage & frequency variation upto above limits.		
	e.	Class of protection	IP – 54		
	f.	Rated capacity (KW)	The motor shall be suitable for 150 starts / hr and 40% CDF. Motor nameplate rating at 40° C shall have Motor rating will be calculated keeping margin of at least 10% over the maximum power requirement in the duty condition specified.		
	g.	Duration factor/duty	40% CDF / S-4		
	h.	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B.		
	i.	Number of starts/ hour	150 starts / hr.		
	j.	Pull out torque	The pull out torque of the motor will not be less than 225% of the full load torque at rated voltage and frequency.		
	k.	Space heater requirement	For motors above 30 KW rating		
3.15.0		**Limit switches**	**MH**	**CT**	**LT**
	a.	Type	Rotary gear (screw type) +Gravity limit switch	Lever type (two-way/one-way)	Lever type (two-way/one-way)
	b.	Number provided	1+1	1/2	1/2
	c.	Control voltage / Enclosure	110V / IP-55		
3.16.0		**Power conductors (DSL)**			
	a.	Type	LT: PVC shrouded Cu conductor bus bar. CT: Flexible trailing cable mounting on retracting support (Festoon type) EPR insulated and CSP Sheathed type		
	b.	Length	Suitable for entire bay length		
3.17.0		**Control Panel**			
	a.	Material	Rolled sheet steel 2mm size, fabricated from CRCA sheet steel		
	b.	Numbers and location	One each for MH, CT and LT located on bridge platform		
	c.	Degree of protection	IP 54		
	d.	Illumination	Internal illumination with florescent lamp		

3.18.0		**Cable**	**Power**	**Control**
	a.	Material	Copper	Copper
	b.	Type	FRLS-insulated, multi strand Copper PVC sheathed armoured cable(for fixed cable) and EPR insulated CSP sheathed cable (for flexible cable)	
	c.	Size	Suitable size	Suitable size
	d.	Voltage grade	1100 V	
	e.	Voltage drop deration	Cable from MCC board to motor terminal shall be so sized that the voltage drop does not exceed 5% of rated voltage.	
3.19.0		**Earthing**		
	a.	Material of earthing	G.I / Copper	
3.20.0		**Power supply**	415 V, 3 phase, 4 wire supply at operating floor at centre of bay length	
3.21.0		**Contactors**	AC 4 duty for reversing application. AC 3 duty for non-reversing application	
3.22.0		**Switches**	AC 23 for motor application, AC 22 for other application.	
3.23.0		**Transformer**	Qty. / Rating	
	a.	Control	2 X 100 % - *415/110V*	
	b.	Lighting	2 X 100 % - *415/240V*	
3.24.0		**Illumination**		
	a.	Over Bridge	4 nos 40 W LED Bulbs and 4nos. 240V- 5A 3 pin industrial socket	
	b.	Under bridge	2 nos. 225 W LED lamps	
	c.	For inspection of crane components	One (1) portable 40W hand lamp with 25m length flexible cable for inspection of crane components	
	d.	Hand lamp socket and hand tool sockets	Hand lamp socket outlets (2 pin, 10A, 24V) and power socket outlets (3 pin, 20A, 240V) shall be provided for use of hand tools along with switches.	
3.25.0		**Type of platform required on the bridge**	Chequered plate platform 6 mm thick as per IS :3502	
	a.	Length	Full span length	
	b.	Type of access from gantry girder level to crane bridge	Rung ladder at ends from gantry girder level walkway to crane bridges walkway	
	c.	Type of access to maintenance cage from crane bridges walkway	Rung Ladder	
3.26.0	a.	**Type of control for Hoists/ CT/LT operation**	**Through VVVF drive**	
	b.	Sweep	Sweep shall be attached to the end carriages and to the trolley to remove foreign materials from the rails.	
3.27.0		**Main Isolating switch**	**Main isolating switch at Middle of the bay length (1.5M above operating floor)**	
3.28.0		Emergency Push Button	Two numbers on bridge platform	
3.29.0		Load Cell along with the display	Shall be provided in accordance with the Clause 15.12 of IS 3177.	

3.30.0		**Fire Extinguisher**	
	a.	Type & Size	4.5kg, CO2 type
	b.	Numbers and location	Two nos. on bridge platform.
3.31.0		**Runway rail**	**50mm Square Bar of suitable material as per IS (for complete bay length as specified in this specification). This runway rail shall be fixed (welded) over gantry girder throughout the bay length and crane girder's wheel shall match this runway rail for smooth travelling.**
4.0.0		**Painting & Color Coding**	As per ***Annexure II*** below

Note: *Supply and fixing of runway rail over gantry girder at both ends for complete bay length and suitable wheel alignment shall be under contractor scope.*

7.0 Works Excluded

1. Receipt of material, Unloading and safe storage of all material/components of EOT crane.
2. Supply of steel gantry girders for LT.
3. For EOT crane, the purchaser shall provide single point 415V, 3 phase, and 50Hz power feeder at any point of the bay or in the middle of the bay as specified in the Data sheet. Vendor shall provide main isolating switch at 1.5 M above the ground / operating floor level and cable required from isolating switch to DSL.
4. Any other supply required by the bidder shall be arranged by the bidder himself by using suitable transformer as per the specification.
5. Supply of Power and control cable (Except for the cables being provided as a standard part of crane). Cables upto Isolating switch shall be supplied by purchaser and remaining by contractor.
6. Supply of cable tray/ racks.
7. Supply of earthing flats.

8.0 Functional Guarantee (at site):-

A. Load test as per IS 3177(Latest edition)
B. Overload test as per IS 3177(Latest edition)
C. Limiting deflection check of bridge girder as per IS 3177 (latest edition)
D. The successful bidder shall furnish their recommended procedure for carrying out the Erection and Commissioning.

9.0 Make of Sub - Vendor items

Makes of bought out items as per Annexure-III 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.

10.0 Various Heads to be quoted

Sl No.	Item Description	Qty	Unit	Unit Ex-Works	Total Ex-Works	Unit ETC	Total ETC	Remarks
1	EOT CRANE : DOUBLE GIRDER - 10 T	1	Set					10T Double Girder EOT alongwith all accessories as per technical specification
2	**Special Tools & Tackles**							As per Annexure-M of technical specification
3	**Mandatory Spares**							
3.1	Pair of brake shoe with lining for each size of brake used viz. D.C. operated E.M, or Hydraulic thruster operated.	2	Set					
3.2	Pair of brake linings with rivets for each size of brake used.	2	Set					
3.3	Main springs for each size of brake used.	2	Nos.					
3.4	Brake coils for each size of brake used.	2	Set					
3.5	Thruster of each size used.	1	No.					
3.6	Pair of oil seals for each gear box used on crane.	2	Set					
3.7	Contactors of each size used.	2	Set					
3.8	Fixed & moving contacts of each size contactor used.	2	Set					
3.9	3 Nos. Coils for each size of contactor used.	1	Set					
3.10	Overload relay for each motor.	1	No.					
3.11	3 No. fuse links of each sizes used on crane	2	Set					
3.12	1 Printed circuit breaker of each size and type	1	Set					
3.13	Complete set of lamps for lightning and signals	1	Set					
3.14	Fuse links of each size used	2	Set					
3.15	Segment of DSL including fitting, jointing, clamping etc.	1	Set					Equivalent to 1 phase installed length for each location
3.16	LT Bearings	1	Set					50% of installed bearings in each crane
3.17	CT Bearings	2	Nos.					
3.18	Motor of each type and rating	1	No.					

3.19	Flood light illumination	1	Set				50 % of installed at each location
3.20	Load cell	1	Set				
3.21	Indication lamp of DSL	1	Set				
3.22	MCCB and Fuses	1	Set				1 Set each
3.23	Auxiliary relay, contactor and timers	5	Set				5 nos. each
3.24	Communication Card/cable	1	Set				One set for one complete crane
3.25	I/O Card	1	Set				
3.26	Processors	1	Set				
3.27	Indicating lamps	1	Set				
3.28	VVVF Drive	1	Set				

ANNEXURE-M

MANDATORY SPARES: (AS APPLICABLE)

Sr. No.	Description of spares	
1)	Pair of brake shoe with lining for each size of brake used viz. D.C. operated E.M, or Hydraulic thruster operated.	2 Sets
2)	Pair of brake linings with rivets for each size of brake used.	2 Sets
3)	Main springs for each size of brake used.	2 Nos.
4)	Brake coils for each size of brake used.	2 Sets
5)	Thruster of each size used.	1 No. each
6)	Pair of oil seals for each gear box used on crane.	2 Sets
7)	Contactors of each size used.	2 Sets
8)	Fixed & moving contacts of each size contactor used.	2 Set each
9)	3 Nos. Coils for each size of contactor used.	1 Set each
10)	Overload relay for each motor.	1 No.
11)	3 No. fuse links of each sizes used on crane	2 Sets
12)	1 Printed circuit breaker of each size and type	1 Set
13)	Complete set of lamps for lightning and signals	1 Set
14)	Fuse links of each size used	2 Sets
15)	Segment of DSL including fitting, jointing, clamping etc.	Equivalent to 1 phase installed length for each location
16)	LT Bearings	50% of installed bearings in each crane
17)	CT Bearings	2 no.
18)	Motor of each size	1 no.
19)	Flood light illumination	50 % of installed at each location
20)	Load cell	1 set
21)	Indication lamp of DSL	1 set
22)	MCCB and Fuses	1 set each
23)	Auxiliary relay, contactor and timers	5 nos. each
24)	Communication Card/cable	One set for one complete crane
25)	I/O Card	
26)	Processors	
27)	Indicating lamps	
28)	VVVF Drive	

Maintenance Tools and Tackles:

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.	Hand Lamp.	1 No.
7.	Line tester	1 No.

ANNEXURE I

TECHNICAL SPECIFICATION FOR VVVF DRIVES, RADIO REMOTE CONTROL & DSL

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 is 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 feedback) like in Travel motions or close loop (With external speed feedback) like in Hoist motions. Chokes on input supply side are generally used in crane application for power regulation. Like all other electronic / electric devices VVVF drives are also protected by MCB / MCCB / Fuses. VVVF drives are sensitive to temperature and hence drive internal as well as external cooling fans are provided.

c) Programming of VVVF Drives.

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

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

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

1.1 Experience

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

1.2 Local support

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

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

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

2.0 Basic requirements for the AC Drives

2.1 General requirements

The 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.

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, and VDE).

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

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

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

Rated Input Voltages	380V -15% 480V +10%, three-phase
Rated Input Frequency	50Hz +/- 5%
Output Voltage	0 – Input voltage, three-phase
Output Frequency Range	0 to 400 Hz
Acceleration / Deceleration Time	0.01 – 999s, adjustable, linear, with S, with U or customised shapes
Overload capability (Constant Torque)	150% of nominal current for 1min.
Operating ambient Temperature	-10°C up to 50°C (shall be derated suitably if not rated at 50°C)
Storage ambient Temperature	-25°C up to 70 °C
Maximum operating altitude	1000 m without de-rating, 1000…3000 (shall be de-rated suitably)
Max. Relative Humidity	95 %, without condensation and dripping water.

Main Protections	Over current, short circuit between phase, short circuit between phase and ground, input phase loss, output phase loss, motor overload, over speed, over voltage, under voltage, drive over temperature

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

3.0 Radio remote Control of EOT Crane:

i) The equipment should have facility to control EOT crane by radio frequency based wireless remote unit. The equipment should be supplied with transmitter unit, receiver unit, encoder unit, decoder unit, interface panel, coupling system, battery unit and any other control gear if required.

ii) The equipment should be based upon the microprocessor based digital technology with almost nil hard wiring.

iii) The remote unit should communicate up to the distance of approximately 100 meters.

iv) The system has to integrate with the control system of crane, which operates at 110 V AC, Single phase.

v) The remote unit should have transmitter which can be mounted on shoulder by suitable belt. Main controls can be of single joystick movement or double joystick movement type stepped control with spring return. The Micro control should be toggle switch type or push control type.

vi) The transmitter and receiver unit should have its own frequency and address code with each system having its own security code so that one particular set becomes unique and there is no interference from any other remote unit device. A microprocessor should check all security codes. The processor should have its own watchdog circuit. The receiver FM band should be sufficiently narrow to allow only passing of desired frequency and valid command. Any error should shut down the system immediately.

vii) The remote unit should have safety key to prevent any unauthorized operation. All the crane operations should stop at once the communication breakdown occurs.

viii) On local unit (receiver side), the system should be provided with one selector switch so that EOT crane can be operated either from Operator cabin or radio remote unit.

ix) In case tandem operation is envisaged, a suitable selector switch shall be provided in the cabin for selection of Tandem/normal operation.

x) The receiver unit along with I/O interface unit should be able to bear the vibrations and shocks

encountered in normal usage of EOT crane.

xi) The system should have very fast response time.

4.0 Power Supply

(a) Incoming numbers: Employer shall provide two (2) numbers 415 volts, 3 phase, 4 wire supply at operating floor. 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 load requirement.

(iii) Protective cover over DSL to be provided.

(iv) Isolating switch in enclosure shall be provided at extreme end of operating floor for disconnecting supply to DSL while maintaining the crane.

Annexure II

PAINTING SPECIFICATION

1. Painting specification for steel structures:-

Surface preparation: De greasing and Mechanical cleaning with wire brush or blasting according to SIS 055900, Grade 2 ½ .

Primer : Zinc Silicate of approved brand. - 2 coat, DFT 60 µm per coat.

Intermediate : MIO Epoxy paint- 2 coat, DFT 90 µm per coat

Finish Coat : Polyurethene coating- 1 coats, DFT 30 µm per coat.

Total DFT : 330µ

2. Painting specification for Indoor components such as motors, electrical parts etc:-

Surface preparation: blasting according to SIS 055900, Grade 2 ½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Primer : Zinc phosphate epoxy - 2 coat, Total DFT 75 µm.

Finish Coat : Chlorinated rubber paint- 2 coats, Minimum DFT 30-40 µm per coat.

Total DFT : 135 – 155 µm

3. Gear Box :

Inside of all gear boxes will be covered with 2 coats of oil resistant paint.

Outside:

Type of coating system	No of coat	DFT µm per coat	Total DFT µm
Primer Coat			
Epoxy Base Zinc Phosphate Primer	2	25	50
Finish Coat			
Epoxy base Paint	2	25	50
Overall minimum DFT µm			100

4. Color Shade:

SL. No	Item Description	Color Shade	Remarks
1	Crane Structure	Golden Yellow shade 356 as per IS-5	Colour band-Black
2	Trolley and hook	Crimson shade 540 as per IS-5	
3	Motors	Light Gray shade 631 as per IS-5	
4	Control Panels	Light Gray (Powder coated) as per IS-5	
5	Gear Box	Light Blue (RAL : 5012)	

ANNEXURE III

MAKES OF IMPORTANT ITEMS / COMPONENTS OF EQUIPMENTS AND THEIR DETAILS MAKES OF SUB VENDORS ITEMS

Bidder shall choose make of materials strictly from list enclosed in Annexure-III to this section only. However final applicable make is subject to ultimate customer approval. Bidder can provide any other make that is not included in the list below under special circumstances only if it is acceptable to ultimate customer without any cost implication to BHEL.

S.N.	ITEM	MAKES
1	STEEL	SAIL/IISCO/TISCO/ JINDAL/ESSAR
2	HOOKS	MOOZUMDAR / KARACHIWALA/ SIMRITI FORGING / HARMAN MOHTA / STEEL FORGING & ENGG. CO. LTD.
3	GEAR COUPLINGS	ALLIANCE / FLEX-TRANS (formerly known as HICLIFF) / OEM / NUTECH
4	WIRE ROPE	USHA MARTIN BLACK / BOMBAY WIRE ROPES / UNITED WIRE ROPE / BHARAT WIRE ROPES / FORT WILLIAMS
5	BEARINGS	SKF/ FAG/ TATA/ NORMA / NBC
6	MOTORS	SIEMENS /NGEF /KIRLOSKAR / BHARAT BIJLI / ALSTHOM / ABB / CROMPTON / MARATHON
7	BRAKES	ELECTROMAG /SPEED-O- CONTROL / EMCO LENZE / BCH (FOR DC BRAKES ONLY) / KAKKU
8	CONTACTOR	SIEMENS / L&T / SCHNEIDER (Earlier TELE MECHANIQUE) / BCH
9	OVER LOAD RELAYS	SIEMENS / L&T / SCHNEIDER (Earlier TELE MACHANIQUE)/ ABB
10	HRC FUSES	SIEMENS / GEPC/ L&T / ENGLISH ELECTRIC / 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/PRAGATI/PRAYOG KAPPA/SOTHERN ELECTRIC/ AUTOMATIC ELECTRIC / PRECISE ELECTRICALS / SILKAAN / NEC
15	BULB & FLOURESCENT TUBES/FITTINGS	PHILIPS/ BAJAJ/ CROMPTON
16	CABLE LUGS (HEAVY DUTY)	DOWELLS / UML ENGINEERING / JAINSON
17	HOOTERS	BEACON / OSC/TARGET / KHERAJ
18	LIGHTING SWITCHES	ANCHOR / ELLORA /BAJAJ/PHILIPS
19	CABLES	

a)	POWER CABLES	NICCO / UNIVERSAL / INCAB / FORT GLOSTER / TORRENT / CCI / ICL / RADIANT / KEI / POLYCAB
b)	CONTROL CABLES	NICCO / UNIVERSAL / INCAB / FORT GLOSTER / DELTON / FINOLEX / TORRENT / CCI / ICL / RADIANT / KEI
c)	TRAILING CABLES	NICCO / UNIVERSAL / INCAB / ICL / KEI
20	CABLE GLAND	COMMET / SUNIL&CO. / ALLIED TRADERS / ARUP ENGINEERING / ELECTROMAC INDUSTRIES / JAINSON
21	PUSH BUTTONS	SIEMENS / L&T / BCH / SCHNEIDER
22	LIMIT SWITCHES	SPEED-O-CONTROL / ELECTROMAG
23	MASTER CONTROLER	SPEED-O-CONTROL / ELECTROMAG
24	SAFETY SWITCHES	ALSTOM / L&T / SIEMENS
25	PENDENT PUSH BUTTON STATION	OEM
26	INDICATING LAMPS	TECKNIC / BCH / SIEMENS / STANDARD
27	MCB	MDS / INDO COPP / STANDARD / SIEMENS/ L&T/ ABB/ SCHNEIDER
28	PANELS	OEM
29	RESISTANCE BOXES	ENAPROS / OEM
31	INSULATORS & COPPER CONDUCTORS	BHEL APPROVED MAKE
32	CASTINGS	KOLHAPUR STEEL/ GNAT FOUNDARY/ KIRTI ALLOYS/ ELECON ENGINEERING COMPANY LTD –FOUNDARY DIVISION/ KARNAVATI TECHNOCAST/ SHUBHLAXMI TECHNOCAST/ SURYADEEP ALLOYSTEEL CASTINGS PVT Ltd / SHREE VALLABH ALLOY STEEL
33	FIRE EXTINGUSHER	BIS APPROVED MAKES
34	VVVF DRIVE	YASKAWA (L&T)/ ABB / SIEMENS / SCHNIEDER
35	SHROUDED DSL	SUSHEEL / STROMAG
34	ANTI COLLISION DEVICE	ELECTRONIC SWITCHES INDIA
35	LOAD CELL	IPA, SARTORIUS
36	RRC	ACROPOLIS ENGINEERING / SNT CONTROLS
37	GEAR BOX	OEM
38	RAIL	JSPL / SAIL

SECTION-2
CUSTOMER SPECIFICATION

Customer specification of Electric Overhead Travelling (EOT) crane is attached in this section.

SECTION-23

EOT CRANES

23.1 SCOPE OF WORK

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

23.1.1 Detailed Scope of Work

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

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

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

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

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

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

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

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

C) 100/20 T EOT cranes for Transformer Cavern

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

D) 10 T EOT cranes for GIS Building

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

E) 50/10T EOT crane for Workshop crane

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

F) Miscellaneous items

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

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

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

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

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

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

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

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

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

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

F) Control, monitoring and related items and services

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

G) Common supplies and services

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

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

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

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

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

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

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

viii) Spare parts as per clause no. 23.11

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

H) Completeness of System

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

23.2 STANDARDS & REGULATIONS

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

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

23.3 PARAMETERS & GUARANTEES

23.3.1 Specific Parameters and Layout Conditions

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

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

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

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

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

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

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

23.3.1.2 150/30 T EOT cranes for PGV House

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

23.3.1.3 100/20 T EOT cranes for Transformer Cavern

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

23.3.1.3 10 T EOT cranes for GIS Building

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

23.3.1.4 50/10 T EOT cranes for Workshop

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

23.3.2 RATING AND FUNCTIONAL CHARACTERISTICS

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

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

A) Power House Cranes

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

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

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

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

B) Transformer Hall Cavern

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

A.	Capacity (in Tonnes)	100/20 T
B.	Span (s)	14000 mm (approx.)
C.	Normal speeds & with full loads	
i)	Hoisting speed for hook hoist	1.0 m/min (Main), 5.0 m/min (for Aux)
ii)	Trolley Travel (Cross)	10.0 m/min
iii)	Bridge Travel (long travel)	25.0 m/min
D	Max. acceleration / deceleration of bridge travel & trolley travel.	0.2 m/sec^2
E.	Crane hook vertical travel reach on transformer floor	10,000 mm
F.	Required hook approach limit from Rail centre line	
i)	On Upstream	≤ 1000 mm
ii)	On Down stream	≤1000 mm
G.	Hook reach from the left & right side walls of Hall end stops on side	≤1500 mm (Right) ≤1500 mm (Left)

	walls	
H.	Runway; Travel lengths	
i)	Crane beam top level	EL562.00 m
ii)	Length of run way	19000 mm (approx.)
iii)	Trolley travel length	Max. Feasible for specified crane span shall ensure hook reaches
I.	Factors of safety & Deflections:	
a)	Minimum Factors of safety for Design	
i)	For structural members based on ultimate tensile strength	The factor of safety and stress level shall be as per IS-807
ii)	For ropes & slings, based on ultimate tensile strength	6
b)	Deflection limit of girder under rated load plus dead loads.	$1/600^{th}$ of span
J.	Means for Micro speed for Inching Motion for main lifting hooks.	Step less, frequency converter speed control system

C) PPV House Crane

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

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

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

GIS building EOT Crane

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

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

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

~~E) Workshop Crane~~

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

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

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

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

23.3.3 Performance Criteria and Guarantee

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

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

i. Main Hoist vertical movement 1.5 mm

ii. Auxiliary Hoist vertical movement 1.5mm

iii. Bridge travel 3.0 mm

iv. Trolley travel 3.0 mm

v. Monorail travel 5.0 mm

The vertical deflection of crane girders caused by the rated load plus all dead load should not exceed the value as per latest IS of the crane span. It is the responsibility of the Contractor to supply the equipment as per relevant standards and shall also guarantee the reliability and performance for the same to meet the provisions of contract.

23.3.4 Safety requirements

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

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

23.4 DESIGN AND CONSTRUCTION

23.4.1 General

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

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

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

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

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

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

23.4.2 Arrangement of Operator Cabins

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

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

~~23.4.3 Simultaneous Operation of Hoist (for Power House Crane)~~

~~The cranes will be required to handle hydro generating plant and machinery, for lighter equipment independently and for heavy equipment in tandem.~~

~~Normally one hoist would be operated at a time. It shall however be possible to change the position of the components from lying to vertical position using both the hoists, by manipulation of the hoisting and other movements as the case may be.~~

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

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

~~During joint (tandem) operation, both the cranes shall be coupled electrically and mechanically and all operations and controls of both the cranes shall be carried out by a single operator, common for both the cranes, from only one of the two crane control cabins. Suitable provisions in the design shall be made to enable and ensure that all operations and control of both the cranes shall be perfectly synchronized for all travel and hoisting motions.~~

~~The 2 cranes shall have provision for coupling mechanically and electrically with ease and reliability for this purpose. When operating in tandem the 2 cranes shall maintain horizontality of the lifting beam in all motions during such operation.~~

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

~~The Contractor is responsible for all co-ordination.~~

23.4.5 Loadings for Crane Design

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

23.4.5.1 Combination of Loadings on crane

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

a) Dead load + Live Load + Vertical Impact Load

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

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

2 **Crane in motion**

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

b) Dead load + braking load.

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

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

3 **Crane Stationary**

Dead load + Earthquake load.

23.4.6 Performance/Quality of Operations

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

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

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

b) Control of bridge and trolley motion to within 10 mm.

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

d) The vertical deflection of the main girders caused by the rated load plus all dead loads not to exceed 1/900th of the crane span for all Cranes

23.4.7 Fabrication At Works Only

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

23.4.8 CONSTRUCTION DETAILS

23.4.8.1 **Structural parts of crane**

A **Crane Bridge**

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

2 The bridge shall be designed taking into consideration the specified transport and handling limits in regard to size and weight of packages. Accordingly, the bridge shall be sectionalized into suitable but minimum no. of sections within the transport constraints as also of field erection & handling.

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

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

fire extinguishing shall be provided on the bridge suitably located.

The bridge shall have the following provisions:-

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

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

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

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

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

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

B Trucks (End Carriages)

1 The trucks of box type construction with openings at each end for receiving the truck wheels shall be either cast, or weld fabricated, or bolted, or riveted structure of steel and shall have adequate strength and stiffness. Two end carriages will be provided on each end of the crane and will be connected with an equalizing beam to take care of any track variation and for equal load sharing.

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

3 Wheel assembly shall be so arranged that replacement of any wheel can be achieved from the side without undue difficulties. The wheel base shall not be less 4 m, as reckoned between

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

4 Each truck shall have

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

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

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

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

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

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

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

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

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

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

C) Wheels, Axles and Wheel Bearings

1. Wheels

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

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

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

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

iv) Equalized in pairs

v) Flanges tapered and radiused to prevent derailment.

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

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

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

2 **Wheel Axles**

The wheel axles shall be as per the following

a) Made of forged carbon or alloy steel.
b) Accurately turned, grounded and polished at the fitting positions in the wheels.
c) Suitable interference fit with the wheels
d) Driving wheel axles to be keyed also in addition to interference fit

.3 **Wheel Axle Bearings**

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

a) Bearing housings/journals fitted into truck bodies.

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

c) Roller bearings with high pressure grease lubrication.

D) **Trolley**

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

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

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

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

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

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

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

.1 **Operator Cabin**

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

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

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

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

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

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

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

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

h) Fan

.2 **Walkways and Ladders**

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

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

b) Steel ladders and stairs to have non-slip treads, not less than 600 mm wide between sides, preferably sloped forward, and provided with back safety guards in case height of ladders exceeds 3 meters.

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

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

.3 **Safety Guards**

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

a) For gears, chain drives : encasements

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

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

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

~~F~~ ~~Lifting Beam~~

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

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

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

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

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

23.4.9 **Mechanical Equipment Details**

23.4.9.1 **Bridge Travel Mechanism**

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

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

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

23.4.9.2 **Trolley Travel Mechanism**

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

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

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

1 **Hoist Drive For Normal Speed**

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

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

a) Very slow, accurate and controlled operation will be required to place the generator rotor and other heavy equipments very gently. The hoist shall have such provision by means of stepless, frequency converter speed control system, enabling control of the

vertical motion of the hoist within 1 mm.

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

3 **Change over device**

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

.4 **Winding Drum**

The winding drum shall be made of cast steel conforming to relevant IS. The winding drum shall have machined grooves to receive the full hoisting rope without overlapping and the drum shall be of such size that there will not be more than one layer of rope on the drum when the rope is in fully wound position and its length shall be such that each lead of rope has a minimum of two full turns on the drum when the hook is in its lowest position and one spare groove for each rope lead off the drum when the hook is at its highest position. The drums shall be designed to withstand the maximum compressive stresses and local bending stresses in the drum at the grooves when the rope is wound on.

.5 **Lifting Tackles and Hooks**

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

b) Sheaves shall be made of cast steel and shall be machine grooved to a depth of not less than 1.5 (one and one half) times the diameter of the rope. The groove shall be finished smooth and shall be free from surface defects likely to injure the rope. The sheaves shall be provided with guards to retain the rope in grooves and other requirements of sheaves shall be as per approved relevant standards.

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

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

.6 **Hoisting Ropes and Slings**

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

b) The Bid shall include requisite wire rope slings of suitable lengths having a safety factor of not less than 6 (six) when lifting specified load with the angle formed at the hook not less than 90 degrees. A minimum of five sets (each set consists of 60T, 40T, ~~for different load~~ 20T, 10T, 5T slings) shall be provided for different loads ~~shall be suitable f~~ up to the rated capacity of hoist

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

d) A wall chart shall be provided showing the maximum safe lift of the slings individually and in pairs at various angles. Each sling and shackle shall have a fixed label on which is stamped the maximum safe lift at 90 deg spread. A storage rack for the sling shall be provided.

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

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

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

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

a) Bridge Travel:

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

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

iii) Automatic EH Thruster brakes for each motor drive end

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

b) Trolley Travel:

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

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

iii) Automatic EH Thruster Brakes

iv) Double (2) brake discs.

c) Hoisting Motion:

i) Main Hoist

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

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

c) Automatic Electro Hydraulic Thruster brake

~~ii) Auxiliary Hoist~~

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

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

~~c) Automatic Electro Hydraulic Thrust Brakes~~

~~d) Mono rail hoist~~

~~i) Hoisting motion Automatic DC EM brake~~

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

~~e) Micro Speed Drive Motor~~

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

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

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

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

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

a) Locking device in the brake lever.

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

c) Emergency stop push buttons.

.6 The wearing surfaces of all brake drums shall be machined and shall be cylindrically smooth and free from defects. The brake lining shall be effectively and permanently secured to the brake shoes during the effective life of the lining and shall be protected from water, grease, oil and other adverse effects for power house and PPV cranes. The brake pedals in case of foot operated brakes shall have non-slip surfaces and it shall be possible to apply the foot brakes with a force not exceeding (245 N) 25 Kgf.

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

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

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

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

23.4.9.5 **Gears**

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

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

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

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

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

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

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

g) Oil level indicator.

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

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

23.4.9.6 **Shaft**

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

a) Material- high tensile rolled steel.

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

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

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

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

23.4.9.7 **Bearings**

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

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

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

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

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

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

The arrangement shall comprise of the following :-

a) Pressure lubrication system comprising gun for lubrication of

all easily accessible grease type bearings provided with grease nipples.

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

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

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

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

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

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

23.4.9.9 **Drip Pans And Covers**

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

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

23.4.9.10 **Bumpers**

Spring bumpers shall be attached to the bridge trucks and the trolley. The bridge shall have four bumpers one at each corner arranged to meet the crane stops squarely. The trolley shall have two spring bumpers on each side placed to ensure that the track stops squarely at the end of the stops. The bumpers shall consist of suitable resilient type capable to absorb the moving energy as per FEM standard.

These shall be fastened to the trucks and the trolley, and shall be capable of bringing the crane and the trolley to a gradual stop when travelling at rated

speed in either direction, when the power supply is suddenly cut-off and thus, eliminate excessive stresses and damage to any part of the crane.

23.4.9.11 **Holding Clamps Against Earthquake**

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

23.4.10 **Electrical power drive equipment details**

23.4.10.1 **General**

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

23.4.10.2 **Detailed specification of individual equipment**

.1 **Motors For Various Motions**

a)	Motor Standards	As per IS:325-1970 & 3177-1977
b)	Capacity	Of ample capacity to withstand respective duties. Full load torque of motors to be higher than the maximum load torque.
c)	Type & Enclosures	All motors should be squiral cage type to suit 415 V AC, 3 phase, 50 HZ, 4 wire power supply system and be totally enclosed type with or without fan cooling arrangement. The motor shall be suitable for direct on line starting any hoisting/lowering rated load, even in event of frequency control system being out of order. Protection IP-54.
d)	Variation of voltage & frequency	Voltage ± 10% Frequency: ± 3% Any combination values of voltage & frequency variations up to above limits.
e)	Pull out torque	Not less than 2.25 times the full load torque of motors at rated voltage and frequency.
f)	Insulation	Class-F.
g)	Time Rating	One hour for all motors. .
h)	Temp. Rating	Temperature rise not to exceed the limits in Table 1 of IS: 325- 1970. Max. Temperatures rise at full load measured by resistance method shall not exceed 60 ^{o}C over the average ambient temp of 40 ^{o}C .
i)	Rated syn.speed	To suit duty for various motions.

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

.2 **Limit Switches**

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

Motion/ Travel	Travel	Raising	Lowering	Emergency 'up' limit

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

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

23.4.10.3 Electrical controls and protection for operation of cranes

General

~~For Power House Crane:~~

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

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

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

~~For PGV House/ transformer Hall Crane:~~

~~The crane shall be provided with control gear located in the operator cabin from where it shall be normally operated by the operator. The control gear shall control all motions and various speeds up to the normal speed.~~

Control Switches, Levers and Speed Controls

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

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

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

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

23.4.10.4 Speed Regulation

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

The maximum acceleration produced by the control system shall be independent of the rate of change of the control lever position. The speed in the first lowering position shall not exceed 5% of the synchronous hoist speed when lowering any load up to rated load. The speed in the first hoisting position when lifting any load up to 125% of rated hoist capacity shall not exceed 5% of the synchronous hoist speed.

23.4.10.5 ~~Tandem Operation (for Power House Crane)~~

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

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

~~.3 Controls for changes in the speeds of the hoisting motor in the lowering direction shall be under the direct control of the operator and shall enable~~

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

23.4.10.6 **Operation of Brakes**

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

23.4.10.7 Electrical Interlocks

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

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

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

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

The controls shall have following provisions :-

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

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

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

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

f) The radio control push button station with proper indication.

23.4.10.8 Automatic Electrical Protection

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

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

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

c) Double pole fuse switches for control and protection of all motor circuits.

d) Circuit breaker located in operator cabin of 3 pole, 415 V, A.C, totally enclosed type for power supply tapping from the main collectors, with interrupting capacity not less than 20 KA with short circuit, overload & under voltage trip devices and one shunt trip coil and prevention against single phasing, 3 timer relays.

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

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

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

23.4.10.9 Particulars of control gear for equipment

.1 **Motors**

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

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

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

.2 **Resistors**

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

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

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

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

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

.3 **Circuit Breaker/Controllers**

Each main supply circuit breaker or contactor shall have an interrupting capacity of not less than 40,000 amperes for higher rating cranes and 10,000 amperes for 10 T crane symmetrical at 415 volts. All switches, contactors, primary relays and primary circuits on the controller shall have a thermal capacity corresponding to 40,000 amperes for higher rating cranes for one second without injury and shall have a rating of at least 660 volts and capacity ratings in accordance with the British Standards or IEC. Allowable temperature rises shall be as prescribed in the Indian or other equivalent standards and based on an ambient temperature of 40 deg.C.

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

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

23.4.10.10 Power supply tapping and other electrical arrangement

Collectors

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

Trolley conductors

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

23.4.10.11 Down Shop Leads (Main Runway Conductors)

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

23.4.10.12 Wiring

All electrical wiring shall conform to IS: 1554 (part-I)- 1964 "PVC insulated (heavy duty) electric cables; for working voltage upto and including 1100 Volts". All conductors for primary power, lighting and control circuits shall be insulated for not less than 1100 volts and shall have standard moisture resisting double braid coverings. All conductors between the secondaries of the motor contactors and resistors shall have sufficient current carrying capacity in accordance with the standard specifications and shall be insulated with 1100 volts class asbestos, high temperature type tropical insulation with moisture resisting impregnation. The primary conductors to the motors shall have standard, continuous current carrying capacity of not less than 100% of the rated full load primary current of the motors. All control and lighting conductors shall be of copper and of suitable sizes. All the wiring shall be subject to approval of the Purchaser. All wiring shall be laid in hot dip galvanized metal conduits.

23.5 AUXILIARY SYSTEM AND MISCELLANEOUS COMPONENTS

23.5.1 Illumination and convenient outlets

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

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

23.5.2 Earthing

.1	The crane structure, motor frames and metal cases of all electrical equipment including metal conduits or cable armoring or guards shall be efficiently bonded to facilitate earthing as per latest edition of Indian Electricity Rules 1956 and latest edition of IS-3043.
.2	The contractor shall provide an earthing system to which all equipment under his scope of supply shall be interconnected. This system will in turn be connected by the Purchaser to the power house earth mat or the PPV earth mat to be laid by the Purchaser.

23.5.3 Rails and other Miscellaneous Items

23.5.3.1 Runway Rails

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

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

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

.4 The rail section shall be selected to suit the crane and the load to be handled. The faces of the rail lengths shall be inclined at angle of 45 degrees to the length to provide oblique faces between rail lengths to prevent jerking of the crane bridge while crossing the gaps.

~~**23.5.3.2 Towing Equipment (For Power House Crane)**~~

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

~~**23.5.3.3 Anti-collision devices (For Power House Crane)**~~

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

~~.2 The anti-collision devices which may be of mechanical actuator-limit switch type or any other suitable type shall be installed on the cranes. Details of device shall be furnished.~~

23.5.3.4 End Stops

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

23.6 DRAWINGS, DOCUMENTS AND DESIGN CALCULATIONS

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

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

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

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

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

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

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

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

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

23.7 SHOP ASSEMBLY, INSPECTION AND TESTS

23.7.1 Shop test

23.7.1.1 Testing of Crane Assembly

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

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

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

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

iv. All other tests as mentioned below.

a) Part-I De-energized Tests

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

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

b) Part-II Energized Tests

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

c) Part-III Function Tests (No Load)

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

d) Part-IV Deflection Test

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

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

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

23.7.2 Field test

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

Test on Rails

i) Leveling and alignment of sole plates
ii) Measurement of span, diagonally, straightness, waviness, (horizontal and vertical) as per approved drawings.

B No-Load Static Tests

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

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

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

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

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

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

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

viii) Operational tests on all protective devices.

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

C No Load Operation Tests

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

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

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

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

D Rated Load Tests

a) Hoist

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

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

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

b) Trolley Travel

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

c) Bridge Travel

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

E **Overload Tests**

a) Hoists

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

b) Bridge

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

c) Travel

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

F **Test Load Frames**

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

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

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

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

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

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

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

A **De-Energized Tests:**

i) During commissioning at site

B **Deflection Test**

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

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

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

23.7.4 Performance testing

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

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

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

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

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

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

23.8 PACKAGING, HANDLING & SITE STORAGE

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

23.9 SITE INSTALLATION AND COMMISSIONING

23.9.1 General

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

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

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

23.10 TOOLS AND INSTRUMENTS

23.10.1 Tools for erection and Installation.

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

23.11 SPARE PARTS

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

23.11.1 Mandatory Spare Parts

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

23.11.2 Recommended Spare Parts

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

SECTION- 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

3.1 PROJECT DETAILS

Name of the Project:	**4x225MW , Arun-3 HEP ,Nepal**
Name of the Customer:	**SAPDC**
Name of Consultant :	**SJVN**

SJVN Arun-3 Power Development Company (P) Ltd. (SAPDC), a company promoted by SJVN Ltd., as a single shareholder company in Nepal having its registered office at Lokanthali, Kathmandu, Nepal has signed Project Development Agreement with Government of Nepal to plan, promote, organize & execute Arun-3 Hydroelectric Project (900 MW) in Sankhwasabha District. of Nepal.

The bid prepared by the Bidder and all correspondence and documents related to the bid exchanged by the Bidder and the consultant/owner shall be written in the English, provided that any printed literature furnished by the Bidder may be written in another language, as long as such literature is accompanied by a translation in English, in which case, for purposes of interpretation of the bid, the translation shall govern.

3.2 Location & Land Availability:

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

- Latitude …….. .27^{O}30'N – 27^{O} -35'N
- Longitude …….. ...87^{O} -12'E – 88^{O}-20'E

• Distance from Tumlingtar (domestic airport) town is……About 68 km

• Distance of Kathmandu (international airport) from Tumlingtar…..About 660.km

3.3 Climatic Condition

Average max temp: 30° C

Average Minimum Temp: 20° C

Maximum river water temperature: 25°C
Minimum river water temperature: 10°C
Ambient Temperature for the Equipment: 40° C

3.4 Seismic Zone

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

3.5 Transportation

Unless otherwise specified in the **Specification**, responsibility for arranging transportation of plant and equipment lies with the Contractor. The Contractor shall at its own risk and expense transport all plant and equipment to a destination specified in bid document. The contractor shall transport the contracted plant and equipment/ supplies through registered common carriers only.

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

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

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

Road access to Arun-3 project from Kolkata to Jogbani is 600km; from Biratnagar to Project Area via Hile is 300km. Total distance to project area from Kolkata is 900km. Alternative route could be from Kolkata to Raxaul which is 800km, further from Birganj to Dhalkebar to Hile to Project Area which is 450km. Total distance Kolkata to Project Area is 1250km.

Local transportation, insurance and other services incidental to the delivery of facilities to be supplied from Employer's country (Schedule- 2 Items) shall be quoted separately.

3.6 Transport Limitation

The transport limitation by road from Jogbani to the project site is the governing factor for determining permissible package size and weight.
The existing roads allow the transport of the packages of the following size and weight.
Size (in mm) (l x b x h) - 9700 x 6000 x 6000*
Weight (Tonnes) - 70R
Heaviest package to be transported with suitable number of axle for safe transportation of consignment for 70R bridge capacity.

* Height from the ground.

3.7 Salient features of Project

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

A. POWER HOUSE COMPLEX

i. Power House Cavern		Underground on Left bank
ii.	Installed capacity	900 MW
iii.	No. of units	4
iv.	Unit Capacity	225 MW
v.	Size of Power House Cavern	179.50m (L) x 22.5m (W) x 49.5m(H)

B. UNDERGROUND TRANSFORMER CAVERN

i. Size	146.14m (L) x 16 m(W)x 23m(H)
ii. Transformer Type	Single Phase
iii. Number and rating	13 nos. (including 1 spare), 15.75/420/√3kV, 50Hz, 92MVA
iv.Transformer Hall level	El. 552 m

C. Switchyard & Transmission

i.Type of Switching	Gas Insulated Substation and Pothead Yard
ii. Size	207m (L) x 106m (W)
iii. Switchyard level	El. 557 m

iv. Transmission System — 400kV Arun III HEP – Muzzafarpur via Dhalkebar D/c Quad Moose Lines with LILO of both circuits at Dhalkebar 400/220kV substation

3.7.1 SYSTEM PARAMETERS

1	Continuous current carrying capacity (rms) at 40° C ambient temperature.	2000A (min)
2	Short time current carrying Capacity	50kA for 1sec
3	Voltage	400KV/420kV (rms) (Nom/Max)
4	Frequency	50Hz
5	System neutral earthing	Effectively earthed
6	Insulation Level	
a	One minute Dry Power frequency Withstand Voltage (kV rms)	630
b	One minute Wet power frequency Withstand Voltage (rms)	630
7	Switching Impulse withstand(250/2500 microsec.) voltage (kV peak)	1050
8	Impulse Withstand Voltage of arrester housing with 1.2/50 micro sec wave.	1425 kVp
9	Creepage distance	25 (mm/kV)
10	Radio Interference voltage at 320kV	As per CEA guidelines

3.7.2 AUXILIARY POWER SUPPLY

3.7.2.1 AC power

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

3.7.2.2 DC power

DC Systems, ungrounded, with earth fault detection 220V plus (+) 10% and minus (-) 20% for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials loads. Other voltage systems eventually needed, shall be generated from the above systems by means of dc/dc converters, inverters etc.

3.7.2.3 Deleted

3.7.2.4 Cabling & wiring

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

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

All inter cubicle and inter panel wiring and connections between panels of same Distribution Board, Control & Protection panels, Motor Control panels including all bus wiring for AC and DC supplies shall be provided by the tenderer.
Larger size wiring shall be used where needed for the current carrying capacity requirements.

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

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

Wiring shall terminate at terminal blocks at one side only. Where tap connections are required, they shall be made on terminal blocks. Wiring shall be neatly arranged and laid in wire ways accessible from the front door.

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

Each cubical shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part

of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

3.7.2.5 Power outlets

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

3.7.2.6 Terminal blocks

The terminal blocks shall be located to allow a neat and easy connection work and shall be safely accessible while the equipment is in service. Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks. Power terminal blocks shall be rated in accordance with applicable standards, and shall be provided with covers. Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals.

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

The terminal shall be such that maximum contact area is achieved when a cable is terminated.

The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

The conducting part in contact with cable shall preferably be tinned or silver plated.

The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

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

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

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

The arrangements shall be made in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.
Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

At least 20% spare terminals shall be provided on ach panel / cubicle / box and these spare terminals shall be uniformly distributed on all terminals rows.
There shall be minimum clearance of 250 mm between the first / bottom row of terminal block and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

3.7.2.7 Protection requirement

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

3.7.2.8 Switches, Lamps & Instruments

General

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

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

Identification nameplates shall be provided for all control switches, indicating instruments and lamps, in accordance with clause “Nameplates”.
Instruments and controls shall be located so that their dials, indicators and nameplates are clearly readable. Data for all instruments to be provided, including type, size, scale range, electrical ratings, nameplate and name of manufacturer, shall be furnished. Steel panels shall be provided for group mounting of the instruments.

All instruments shall be of an approved type and shall match, insofar as practicable, the other instruments with which they are associated; their dial type, scaled markings and units, type of connection and mounting, shall be co-coordinated. All piping and tubing required for instruments shall be furnished and installed. All instruments and control switches shall be furnished with necessary auxiliaries,i.e. resistors, shunts etc.

3.7.2.9 Control and Selector switches

The switches and push buttons shall be provided with ample contact ratings, suitable cam or block arrangements necessary for the control functions on 230 V AC or 220V DC circuits. The

control switches used in mimic diagrams shall be of discrepancy type with built in lamp indication.
Control and Selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front.
Switches with shrouding of live parts and sealing of contacts against dust ingress shall be provided.
Circuit breaker control switches shall have three positions and shall be spring return to "NEUTRAL" from "CLOSE" and "TRIP" positions and shall have pistol grip handles. They shall have at least two (2) contacts closing in close position, and two (2) contacts closing in trip position unless specified otherwise.
Ammeter and voltmeter selector switches shall have four stay out position with adequate number of contacts for three phase 4 wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries. Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

3.7.2.10 Push buttons

Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 230V AC and 0.5A at 220V DC.
All push buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push buttons shall be provided with integral escutcheon plates marked with its function. The colour of the button shall be as follows:

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

3.7.2.11 Indicating and signaling lamps

Each indicating and signaling lamp shall have a removable cap, which can be inscribed with wording and shall not be affected with the heat of the lamp.
Indicating lamps are preferably of LED type & low watt consumption and shall be replaceable from the front of the panel. The indicating and signaling lamps shall be of the same size and type.
Lamps shall be provided with series resistors, preferably built-in the lamps assembly.
The lamps shall have escutcheon plates marked with its function, wherever necessary.

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

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

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

3.7.2.12 HRC Fuses

HRC-Fuses shall have visible operation indicators.

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

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

3.7.2.13 Indicating instruments and Meters

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

The instruments shall accurately measure and indicate the quantity under all conditions of operation with minimum instrument errors. Changes in ambient temperature within the range prevailing at site shall not affect the accuracy Contact making instruments shall have contacts suitable for 240 V AC or 220 V DC circuits.

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

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

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

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

3.7.2.14 Integrating instruments

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

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

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

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

3.7.2.15 Measuring converters

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

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

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

3.7.2.16 Measuring transformers

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear

enclosure, when the distribution board is operating at its rated condition and the outside ambient temperature is 40 deg.C.
All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.
All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

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

The parameter & rating of CTs & PTs are minimum requirement & tentative only. Contactor shall submit the calculations for selection of CT/PT for approval to purchaser. Potential transformer secondary windings shall be rated 110 / V3 V Current transformer secondary windings shall have a rated current of 1A / 5A.

3.7.2.17 Nameplates and Labels
Each major and auxiliary item of equipment shall have a nameplate permanently affixed thereto, or as directed, showing in a legible and durable manner the serial number, name and address of the manufacture, rated capacity, speed, electrical characteristics, and other significant information, as applicable.
The module identification plate shall clearly give the feeder number and feeder designation wherever applicable. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.
All name plates shall be of non rusting metal or 3-ply lamicoid with white engraved lettering on black back-ground, inscriptions and lettering sizes shall be as per their standard practice. Suitable plastic sticker labels shall be provided for easy identification of all equipment, located inside the panel/module. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the module wiring drawings.

3.7.2.18 Motors
All electric motors for driving various equipment shall conform to relevant standards viz. IEC, BS or IS as applicable. The motor rating, torque characteristics, speed etc. shall be selected to suit the duty requirements.
Type of starter for motors shall be duly approved by the purchaser during detailed engineering. The detailed design calculation for selection of type of starters is to be submitted for approval. The priority for type of starters shall be in the following order:
1. Variable frequency drive
2. Soft starter
3. Star delta/ auto –transformer
4. Direct on-line starter

The enclosure of each motor shall be of the type best suited for the service conditions of the motor. The motor insulation shall be resistant to moisture, oil or oil vapor and the motors in general shall be so designed as to suit the tropical climate. Varnished cambric or glass insulation class F shall be used for connection from the windings to the terminals.
The terminal box shall be closed conduit box type conveniently located, and shall have means for terminating the external wiring for outdoor use. The motor terminals shall be of the stud type totally enclosed. Eye bolts or lugs shall be provided for lifting.
Space heaters to avoid condensation shall also be provided. Special type of motors, not adequately covered by these specifications, shall be offered for any special application, but these shall be subject to the approval of purchaser.

3.7.2.19 Space heaters

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

3.7.2.20 Auxiliary relay, contacts and devices

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a draw out construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-draw out cases.
All AC auxiliary relays shall be suitable for operation with VTs and CTs secondaries.
DC auxiliary relays shall be designed for 220V DC unless otherwise specified and shall operate satisfactorily between 80% and 110% of the rated voltage. Relays shall have adequate thermal capacity for continuous operation in circuits in which they are used.
All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.
Suitable number of auxiliary contacts or auxiliary relays shall be provided with each VCB's / ACB’s for indication, remote indication, annunciation and automatic changeover and interlocking scheme.
All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flag) for analysing the cause of operation.

3.7.2.21 Welding & NDT

Preparation of base material

Members to be joined by welding may be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. Edges shall be

shaped according to ASME requirements. Design of welded joints and selection of weld filler metal shall be in accordance with approved standards and shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces to be welded shall be sound metal free of visible defects such as laminations or defects caused by cutting operation at least 30 mm back from the edge of the weld, and free from rust, oil, grease, and other foreign matter.

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

3.7.2.22 Field welding

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

Preparation for field welding

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

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

3.7.2.23 Painting

All the equipment furnished and installed by the Contractor shall be completely painted for final use, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and required number of coats. The Contractor shall perform all painting work in the shop, before shipment, followed by a final coat of paint at site after installation as per the standard procedure.

All materials, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers. Colour schedule of equipment supplied shall be finalized during detailed design stage.

3.7.2.24 Galvanization

All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process commences. All galvanizing shall be done by the hot dip process with smelter, not less than ninety eight percent (98%) of which must be pure zinc. No alternative

process shall be used without the approval of the purchaser. No components shall be galvanized which are likely to come into subsequent contact with oil. Bolts shall be completely galvanized including the threads, but the threads shall be left uncoated in the case of nuts.
The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. In the case of component parts the zinc coating shall weigh not less than 0.6 kg/m2 over the area covered and be not less than 0.09mm in thickness. All galvanizing shall comply with the requirements of the relevant ASTM standards/Indian Standards. All galvanized parts shall be protected from injury to the zinc coating due to differential aeration and abrasion during the period of transit, storage and erection. Damaged areas of the coating shall be touched up with an approved zinc dust paint or other approved flake metallic compound.

3.7.2.25 Pumps

All pumps forming part of the generating units and other plant and equipment shall be of high performance requisite type (viz. centrifugal, rotary etc.) and rating, of reputed make, and shall be directly coupled to their driving motors. The pumps shall be of self-priming type and with proper sealing systems and protection.
The materials of construction of pumps in general shall suit the service conditions. The materials of construction of the pumps handling water, such as drainage & dewatering pumps, turbine top cover drainage pumps etc. shall be resistant to abrasive effects of silt in such water. The pumps shall operate quietly without undue noise and vibration in their full operating range of head and flow. They shall be easy to maintain.

3.7.2.26 Embedded parts, Anchor Bolts and Fasteners

All embedded anchor bolts, rods, pipes, welding plates and support plates shall be provided by contractor. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is embedded. The threaded end of the rod shall be provided with two steel nuts and two steel washers to permit leveling and anchoring the equipment prior to grouting.
Approved types of expansion or chemical anchors shall be used where practicable for small equipment.

3.7.2.27 Rust Prevention and Protection during Transit:-

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

3.7.2.28 Civil Works

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

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

3.7.3 Erection, Testing, Commissioning and performance of Guarantee Tests

3.7.3.1 Testing and inspection

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

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

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

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

3.7.3.2 Dimensional Checks and Visual Inspection

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

3.7.3.3 Functional Tests

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

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

3.7.3.4 Erection, commissioning & field tests

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

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

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

3.7.3.5 Installation procedure

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

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

3.7.3.6 Cable laying

Wiring between equipment enclosures shall be made with cables, laid in trenches and/or cable trays and in cable conduits. The Contractor shall submit for review to the Engineer a cable route layout-showing location of trenches, conduits and trays. All material for cable laying such as cable trays supports and fastening material shall be furnished and placed by the Contractor. Cables shall be properly fastened and marked where they enter enclosures by either cable clamps or nipples.

Cables in horizontal cable trays shall be fastened properly with clamps or plastic strips. Power and control cables shall be placed in separate trays or conduits. Cables shall be clearly marked at each terminal point and appropriate intermediate locations as per Standard.

Conduits shall be of heavy gauge rigid steel, hot-dip galvanized, cut square reamed, threaded and screwed tight at all joints.

Conduit entrances to pull boxes and switches shall have double lock nuts & insulating bushings. No running thread shall be used.

Flexible metallic conduit shall be used for connection to equipment, which are subject to vibration, and also for connection to level/limit/pressure switches.

3.7.3.7 Field inspection

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

Unless otherwise specified, any rejection based on the inspection will be reported to Contractor within fifteen (15) days.

3.7.3.8 Field tests

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

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

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

Any defects or leaks disclosed in the tests shall be duly mended/ repaired to meet the desired function and retested. All necessary materials and labour for performing all the above tests shall be provided by the Contractor.

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

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

3.7.3.9 Taking over of facilities

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

3.7.3.10 Operation acceptance

The operational acceptance by the Employer of the Facilities (or any part of the Facilities where the Contract provides for acceptance of the Facilities in parts), which certifies the

Contractor's fulfillment of the Contract in respect of Functional Guarantees of the Facilities (or the relevant part thereof) in accordance with the provisions of Specification.

3.7.3.11 Consumables, oils and Lubricant

The Contractor shall deliver to the Owner all equipment complete with initial fill of fluids, grease or lubricants, transformer oil, Nitrogen, SF6 gas and other used gases in non returnable drums / containers and replace any quantity used up or lost during installation and testing.
The oil used for the lubrication and oil pressure systems for the turbine, governor, shutoff valve and generator shall be preferably of the same type.

Supply

The Contractor shall furnish the following:
(i) All oil for initial filling of all equipment supplied, plus additional oil equivalent to the first filling requirement of one unit.
(ii) Grease if required for initial filling of all of the equipment, plus 10% additional.
(iii) Gases for initial filling of all equipment supplied, plus 10 % additional quantity.
(iv) Flushing fluids to flush and clean all systems.

3.7.3.12 Deleted:

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

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

Loading drawings

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

Foundation drawings

If a piece of works requires its own foundation or needs a special area for installation, the contractor shall submit drawings indicating all pertinent dimensions, static and dynamic loads, etc. They shall include all essential details required for proper design and construction of the foundations and/or buildings.
In addition, they shall include openings, sleeves, slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

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

Arrangement drawings

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

Outline drawings

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

Design drawings

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

- 3-D Assembly drawings for major components in hard and soft form.
- Details of manufacturing and treatment of major single work pieces specially manufactured for this Contract
- Assembly of the Works in plan and elevation with main dimensions Sub-assembly of the principal components of the Works with overall dimensions, adjustment and clearance tolerances, numbers of corresponding detail drawings
- Sub-assemblies in which the Contractor proposes to ship the Works
- All necessary details of the parts connecting to the Works supplied by others
- Location and sizes of auxiliary connections for oil, grease, water, air, electrical power etc.
- Location and size of the instruments and accessories provided
- Methods of lubrication and sealing
- Instructions for heat treatment, pressure tests, surface preparation and anticorrosive protection
- Full details of parts for which adjustment is provided or which are subject to wear
- Method and sequence of installation, field joints, erection and lifting devices, jacks, grout plugs, anchoring details, etc., if not shown on foundation drawings.

Installation drawings

The construction, mechanical, electrical and I & C Installation Drawings shall provide detailed information on the disposition of the various items of a system (e.g. lighting fixtures, socket

outlets, connection boxes, transmitters, actuators, loudspeakers, telephones, pipes, valves, pumps, compressors, etc.) and of the piping and wiring respectively included in the installation or assembly. They shall be based on dimension drawings of cubicles, rooms, buildings or areas containing the Works.

Diagrams

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

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

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

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

Terminal diagrams
Such diagrams shall be prepared for any type of terminal box, marshalling rack, control cubicle, switchboard, etc., and shall show the terminals (properly numbered) and the internal and/or external conductors (wires or cables) connected to them.
The terminal diagram of each individual switchboard, terminal box, panel, etc., shall contain, but not be limited to the following information:

Protection co-ordination diagrams
These diagrams shall show in a graphical manner separately for each power supply circuit:

- A simplified single-line diagram of the circuit with technical data of all instrument transformers and relays

- Co-ordinated tripping curves of related protection devices
- Setting of the protection devices.

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

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

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

Sr.No.	Manual Description
1.	Storage and preservation manual
2.	Safety manual
3.	Erection Manual
4.	Testing and commissioning manual
5.	Operation manual
6.	Maintenance manual
7.	Long term storage manual for Generator Transformer
8.	Long term storage manual for boxed up component / equipment.
9.	Repair process / procedure manual for equipment / system

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

Drawing & Document Submission Schedule
Drawings & documents submission schedule of the EM package with the categorization (i.e. Approval / reference) & tentative submission date shall be submitted to purchaser.

Preliminary list of drawings under various categories have been prepared and appended at Section 1 of the Technical Specification.

3.8 DRAWINGS & DOCUMENTS TO BE SUBMITTED BY THE SUCCESSFUL BIDDER AFTER AWARD OF CONTRACT

One set of soft copies of all the approved drawings, documents including as built drawings shall be furnished by the Bidder to the Owner / Consultant in compact discs.

White prints or other non-reproducible drawings can be mailed folded. Blue prints shall generally not be used.

All drawings, prepared by the Bidder shall be as per IS: 696. Supplier's standard drawings are exempted from the above size limitation, unless his "standard" includes drawings of very large size or length. There shall be sufficient reference notes on the drawings to permit identification of all the drawings which are required for a proper understanding.

Bills of material and drawings shall be cross-referenced for easy identification.

All drawings shall be dimensioned in the metric system. Where drawings are usually made in the British (or other) system, they shall also have metric system dimensions in parentheses or below dimension line. Titles and written notations shall be in English. If the original is in another language it shall carry English translation. The translations will appear immediately on the drawings. Attached lists of translated words shall not be accepted.

Drawings and bills of material shall be identified by a numbering system to be mutually agreed later on. Any additional identification numbers or symbols that the Bidder selects to use for his own purposes are permissible so long as Owner's number is the prime means of identification.

The scale of the drawing shall be shown clearly in the title block of the drawing. Wherever possible, scales of drawings shall be:-

1:1	1 : 2.5	1 : 5	1 : 10	1 : 20	1 : 25
1:50	1 : 100	1 : 200	1 : 300	1 : 500	
1: 1000	1 : 2000	1 : 5000			

All reproducible must be made from original drawings.

All revised drawing shall clearly indicate the number, date and subject to each revision. All the revisions carried out in the drawings shall be clearly identified and marked.

Drawing list shall be kept up-to-date, incorporating all new additions, cancellations and changes, and will be reissued periodically with Progress Report.

General arrangement drawings shall be submitted for approval to the Owner/ Consultant prior to the commencement of detail engineering by the Bidder. These drawings shall show to scale all major equipment including electrical equipment and building outlines and overall dimensions as well as tie-in dimensions and clearances shall be clearly indicated. Approved arrangement drawings shall be used as basis for design and preparation of detail drawing to be prepared by the Bidder. The Bidder shall furnish all the necessary drawings, data etc., of

the plant/equipment with appropriate "Status" stamp in adequate no. of copies as indicated below:

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
			Prints	Prints	CDs
1	Drawings and Data Sheets	1	6	10	-
2	Drawings "As Built "	-	-	10	-
3	Type Test Reports	1	6	10	02
4	Erection Manuals	-	6	10	-
5	Operation and Maintenance Manuals	-	6	10	-
6	Manufacturing Quality Plan	1	6	10	-
7	Field Quality Plan	1	6	10	-
8	Inspection Test Reports	-	-	10	-

All instruction manuals / O&M Manual/"as built drawing": 10 copies each

3.8.1.1 QUALITY ASSURANCE PROGRAMME

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

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

- SYSTEM FOR QUALITY AUDITS.
- SYSTEM FOR IDENTIFICATION AND APPRAISAL OF INSPECTION STATUS.
- SYSTEM FOR AUTHORISING RELEASE OF MANUFACTURED PRODUCT TO THE PURCHASER.
- SYSTEM FOR TRANSPORTATION /DELIVERY, HANDLING, STORAGE AND PRESERVATION.
- SYSTEM FOR MAINTENANCE OF RECORDS.

GENERAL REQUIREMENTS - QUALITY ASSURANCE

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

Minimum Quality Assurance Test Requirement (QATR) to be followed during Manufacturing and Field erection indicating requirement of various tests / inspections, on major equipment / items, to be carried out as stipulated in technical specification and standards mentioned therein, are attached hereto and are part of bidding documents.

Clarification, if any, on these quality assurance test requirement, raised by bidder shall be discussed and resolved during pre-bid meeting.

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

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

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

All major items/ equipment/ components to be manufactured in house as well as procured from sub-vendors (Bought out Items, BOI) to be listed in the bid. Bidder shall submit Quality

Assurance Plan submission schedule in the bid for above listed items in attached Format (duly filled in the format F-060-05 Issue 2.0 Rev. 00, Total 1 Page) in line with L2 Schedule.

For components / equipment / Bought out Items procured by the contractor for the purpose of the contract, the Contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the sub-vendors.
The quality plans called for from the sub-vendors shall detail out, during the various stages of manufacture and installation, the quality practices and procedures followed by the sub-vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc.

Such quality plans of the successful sub-vendors shall be finalized with the SAPDC/Consultant in line with requirement mentioned above and such approved Quality Plans shall form a part of the purchase order/contract between the contractor and his sub-vendor.

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

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

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

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

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

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

The Customer Hold Points (CHPs), identified in approved quality plan, i.e. testing checks which shall be carried out in the presence of the SAPDC, beyond which the work will not proceed without written consent of SAPDC's authorized representative.
The contractor / sub-vendor shall carry out routine test on 100% items at his works. The quantum of check / test for routine and acceptance test by SAPDC/Consultant shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned, quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering.
The quantum of check when specified in percentage (%) / sampling basis shall be treated as per lot per sub-vendor. When the quantum of check is indicated to in whole no., then same quantum of check shall be applicable to each sub-vendor supplying the same equipment.

For sub-vendors identified during pre-award stage for submission of vendor details/ credentials (category "DR"), contractor shall submit documents in format F-060-01 after placement of award in the manner as specified as under prior to any procurement and within a month after placement of award or a period as agreed at the time of pre-award discussions.

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

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

Normally no request for change of sub-vendors or inclusion shall be entertained by SAPDC. But in exceptional circumstances, if the request for change of sub-vendors or inclusion is found reasonable and justified, then the same shall be entertained and the decision of SAPDC in this respect shall be final and binding. The time consumed for the change / inclusion of sub-vendors shall not be excluded from the stipulated time of the completion of the contract. This change shall not relieve the contractor from the responsibility to complete the work within stipulated time in any manner.

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

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

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

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

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

All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American or Indian Society of non-destructive examination). NDT shall be recorded in a report, which include detail of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of correlation of the test report with the job.

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

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

The inspection calls (duly filled in the format F-060-06 Issue 2.0 Rev. 00, total 1 Page) shall be placed at least 06 weeks in advance for overseas inspections excluding India and 15 days in advance for inspections within India and Nepal.
Before submitting the inspection call to SAPDC for witnessing the Customer Hold Points (CHP's) and/or requesting SAPDC for issuance of Material Dispatch Clearance Certificate (MDCC) based on Test Certificate (TC) review / Certificate of Conformance (COC), the contractor shall ensure that all Drawings / documents / GTP / technical data sheet, relevant to respective CHP / MDCC requirement, has been duly approved /accepted / noted by SAPDC.
Contractor shall ensure readiness of offered equipment by all means, before raising such call to SAPDC to attend CHP inspections. In case, SAPDC engineer (s) on reaching at a place of inspection found that material is not ready for inspection due to whatsoever reason, the complete inspection expenditure of SAPDC engineer(s) as per actual shall be chargeable to the contractor.

Only calibrated testing & measuring instruments shall be used while performing tests during manufacturing and erection, testing & commissioning at site by the contractor. Copy of the calibration certificates will be submitted to SAPDC/Consultant by the contractor during inspection as an evidence.

Non-conformities observed during manufacturing, shop testing, handling, packaging, transportation, storage, preservation, erection, testing & commissioning are required to be intimated by the contractor (Format for reporting, F-060-04 issue 2.0 rev 01, Total 5 pages). The acceptance/rejection of the non-conformities will be at the discretion of SAPDC.

Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the acceptance of SAPDC. Action taken in accordance with decision of disposal of non-conformity for repair / rework / modification of the item / equipment and to prevent re-occurrence. The corrective and preventive action may involve modification of item / equipment, change in procedure and system etc. to achieve quality improvement at all stages and levels.

Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the SAPDC to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings etc.

No material shall be dispatched from the manufacturer's works before the same is duly accepted, subsequent to pre dispatch/final inspection including verification of records of all previous tests/inspection by SAPDC and duly authorised for Dispatch by issuance of Material Dispatch Clearance Certificate (MDCC).

The test reports of type tests conducted as per contract, in line with requirement stipulated in the technical specification / quality plan should be got accepted from SAPDC/Consultant before final inspection / issuance of MDCC.

All materials used or supplied shall be accompanied by valid and approved material certificates and tests and inspection reports. These certificates and reports shall indicate the heat numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it to ensure physical correlation and traceability of material vis-a-vis test certificate. Such identification no. shall remain same and verifiable for all stages of manufacturing and installation.

3.8.1.2 QA DOCUMENTATION

The contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan.

Each QA Documentation shall have a project specific Cover Sheet bearing name and identification number of equipment including index of its contents with page control on each document. The QA Documentation file shall be progressively completed by the Contractor/sub-vendor to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-ROM may be issued not later than three weeks.

Before dispatch / commissioning of any equipment, the Contractor shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The Contractor will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

The contractor shall be required to submit copies of the following quality assurance documents in original duly reviewed and accepted by contractor along with the request letter for issuance of MDCC (Material Dispatch Clearance Certificate):

- QUALITY PLAN CHECK LIST.
- MATERIAL MILL TEST REPORTS ON COMPONENTS AS SPECIFIED IN QUALITY PLAN.
- SKETCHES AND DRAWINGS USED FOR INDICATING THE METHOD OF TRACEABILITY OF THE
- RADIOGRAPHS TO THE LOCATION ON THE EQUIPMENT.
- NON-DESTRUCTIVE EXAMINATION RESULTS REPORTS INCLUDING INTERPRETATION REPORTS.
- CALIBRATION CERTIFICATE OF ALL METERS & MEASURING INSTRUMENTS PROPOSED TO
- BE SUPPLIED AS PART OF RELEVANT BILLING BREAKUP ITEM.
- ROUTINE TEST REPORTS FOR TESTING REQUIRED AS PER APPLICABLE CODES AND
- STANDARDS REFERRED IN THE SPECIFICATIONS.

- INSPECTION REPORTS DULY SIGNED BY AUTHORIZED REPRESENTATIVE OF SAPDC AND
- CONTRACTOR FOR THE AGREED CUSTOMER HOLD POINTS.
- ALL THE ACCEPTED DEVIATIONS SHALL BE INCLUDED WITH COMPLETE TECHNICAL DETAILS.
- LIST OF BALANCE POINTS IF ANY.
- CERTIFICATES IN RESPECT OF CALIBRATION, WELDERS & BRAZERS QUALIFICATION ETC.
- COPY OF ALL REFERENCE DRAWINGS AND REFERENCE TECHNICAL DOCUMENTS
- ACCEPTANCE OF TYPE TEST REPORTS BY SAPDC/CONSULTANT.

Similarly, the Contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/procedures, within 2 weeks after commissioning of individual system.

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Consultant and other set to SAPDC. For the particular case of phased deliveries, the complete quality document to the SAPDC/Consultant shall be issued not later than 3 weeks after the date of the last delivery of equipment.

ASSOCIATED DOCUMENTS / FORMATS

- F-060-01 VENDOR / SUB-VENDOR ASSESSMENT SHEET
- F-060-02 QUALITY PLAN SUBMISSION BY CONTRACTOR.
- F-060-04 NON-CONFORMANCE REPORT (NCR)
- F-060-06 INSPECTION CALL REQUEST.

3.8.1.3 Safety

Safety of personnel

All equipment and services provided under this contract shall abide by international standards commonly accepted in the hydroelectric utility industry for safety of personnel whether involved with operation or maintenance.

Safety of operation

All equipment and services provided under this contract shall abide by commonly accepted standards for safety of operation.

The various system and sub-systems supplied under this contract shall be designed to follow and operate under a clear hierarchical structure:

- Plant control level,
- Unit control level,
- Functional control level, functional drive group level,
- Local drive level.

Each hierarchical control level shall perform its specific tasks and always depend on the subordinate lower control levels. In general, should a higher control level failure occur, the

lower control level shall not be affected and shall be able to control the power plant with full safety.

The Contractor shall accordingly build into the "Electrical & Mechanical System" adequate levels of autonomy, independence, redundancy and functional distribution to insure that safety is maintained at all times.

3.8.1.4 Earthing

Earthing terminals for equipment of these specifications shall form part of equipment supplies. The contractor shall connect the earthing conductors to these terminals as required.

Risers from earthing bus shall be in the scope of purchaser. However, extension from these risers to the equipment shall be in the scope of supplier in the Power House, Transformer Hall, Switchyard and Butterfly Valve House.

However, overall earthing arrangement required for HT panel, LT panel, DG set, motor & motor control panels etc. at isolated location such as Dam Site, TRT Outfall area and Surge Shaft either by pit earthing or counter poise etc. shall be in the scope of supplier including civil works, design, material supply (for main earthing risers, interconnection, charcoal, salt, Bentonite etc.), erection, testing & commissioning etc.

A copper ground bus, sized to carry maximum short circuit current, shall run along the entire length of panel structure and shall have terminal connector at each end for connection to station ground grid (50 X 6 mm G.I. flat).

Tests

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

Special Cables

Special cables for specific purpose, as required, shall be supplied and installed by the Bidder.

3.8.1.5 Completeness of the specification

Any fittings, accessories, equipment or any other things required for successful commissioning of Arun-III Hydro Electric Project, though may not have been specifically mentioned in the specification but are usually necessary for the completeness of the equipment shall be deemed to be included in the specification and shall be supplied by the contractor without any extra cost to the Employer.

3.8.1.6 Packaging and Shipment

The Contractor shall provide such packing of the Goods as it is required to prevent their damage or deterioration during transit to their final destination as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit and open storage. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the final destination of Goods and the absence of heavy handling facilities at all points in transit.

The packing, marking and documentation within and outside the packages shall comply strictly with such special requirements as shall be expressly provided for in the Contract and, subject to any subsequent instruction ordered by the Employer consistent with the requirements of the Contract.
After unpacking of Goods the packing material shall become the property of Employer

The contractor shall wrap, pack and crate all plant included in the work or part thereof, suitable for shipment to a tropical location, facilitating proper handling and protection from damage in rail, truck, ocean or air shipment as applicable. An approved drying agent, such as Silica Gel, shall be packed in containers or packages holding plant which may be adversely affected by moisture or excessive humidity.

All packing crates shall be clearly marked before shipping to indicate the contract number, shipping address, volume, weight, name, number and unit number of the contents, slinging and weight bearing points.

All plant parts shall be marked to facilitate erection. Each packing crate shall contain a packing list in a waterproof envelope. Parts shall be described and also identified by their numbered marking in the packing list.

Three copies of the packing list shall be forwarded to the purchaser prior to dispatch. The ownership of packaging materials shall be of Employer. All wooden packaging crates and steel support structures shall be dumped to the designated area within 5kms of the power house as per the direction of Engineer in charge.

The supplier shall be entirely responsible for the insurance, shipment, handling and transportation.

The equipment shall not be dispatched by the Bidder from the place of manufacture to the site until the dispatch instructions are issued by the Owner.

3.8.1.7 PACKAGING, HANDLING AND SITE STORAGE

The Contractor shall pack all the consignment in sea worthy packaging strong enough to withstand rough handling during transit. Machine surface shall be suitably protected against scratches, corrosion, shocks, impact etc. Packages shall be suitably and distinctly identified for type of handling and kind of storage.

Electronic equipment shall be packaged, shipped and stored in anti-static packing. All packages shall be stored indoor. Packages containing electronic equipment shall be stored in humidity controlled environment.
The Bidder shall indicate the number of packages of consignment together with the size (L x W x H) and weight for transporting the equipment in the Bidding Document.

3.9 SPECIAL INSTRUCTIONS TO BIDDERS

General

The Bidder shall base the equipment design on the information given in this specification. The equipment shall be complete in all respects. Any item which is not specifically mentioned herein but found essential for safe and efficient operation and maintenance and satisfactory performance of the system shall be deemed to have been included in the scope of the Bidder. It shall be presumed that the Bidder has studied the site, all the drawings, tender documents and is fully aware of the scope of work involved and the site conditions prevailing.

3.10 Codes and Standards

a) All equipment, systems and works covered under this specification shall comply, in all respect, with requirements of applicable latest statutes and that of latest editions of codes and standards. Latest regulations and safety & environmental requirements as applicable in India / state of installation shall also be complied with.

b) All codes and standards mentioned shall mean as relevant and applicable to a particular equipment / system.

c) All other codes/standards not covered in Section 1 / Section 2 but required for the plant and system offered shall also be referred / followed by the Bidder. The Bidder, along with the bid, shall submit a comprehensive list of codes and standards to be followed for various equipment / system.

d) In all cases where IBR does not govern, German, American, British, ISO or other international standards established to be equivalent or superior to the codes specified are also acceptable. In the event of any conflict between the requirements of equivalent

codes and standards and the requirements of Indian standards / regulations, the latter will govern unless specified otherwise in the specifications.

e) The Bidder shall be responsible to be in possession of all the specified Codes / Standards and ensure reference to the same before submitting the offer/ bid.

f) Mandatory codes / local regulations to be followed for safety, design, fabrication and operation of the switchyard shall be, followed:

g) If the equipment supplied does not conform to the codes and standards mentioned in this specification, but is manufactured to the Bidder's own standard, developed as a result of his experience, is also acceptable provided the same is found to be superior to the above mentioned codes and standards. The Bidder shall identify such equipment and shall also present sufficient data to the Owner / Consultant to support his design and to establish the superiority. The design may be accepted by Owner/ his Consultants only if the Purchase / his consultant is satisfied that sufficient experience exists with the design proposed.

h) Design not meeting the stipulations of the codes and standards will not be acceptable.

i) Apart from various codes and standards mentioned in Section 1/2, the Manufacturer shall comply with other requirements of codes and standards mentioned in this Specification for detailed design, manufacture, testing, erection, construction etc.

Control System	IEEE – 122 , 1992
Metering / Dosing pumps	API 675 – 1987 (Positive displacement pumps – controlled volume) API 676 – 1987 (Positive displacement pumps – Rotary).
Centrifugal pumps	API 610 – 1990, ASME PTC 8.2 – 1965
Gear Box	API 613 – 1993 & AGMA 420 & 421
Coupling	API 671 – 1993
Structural	IS 1893 – 1991, IS 875-1992 & IS 800 – 1991
Pressure Vessel	ASME Sec. VIII, Div. 1 – 1995
Piping	ANSI B 31.1-1995 / 31.3 – 1993, IBR
Valve	API
Instrument	ISA, API
Electrical	As per specification attached & relevant
	IS/IEC

Tanks	API 650- 1993
Electrodes	AWS, IS
Painting	IS Standards
Performances Tests	
Overload test of crane and hoists	IS 3177

3.11 Deviations and Assumptions

Bidders requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. The Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. In the event of conflict between the Technical Specifications and the condition of contract, the requirements as indicated in the technical specification shall govern, unless confirmed otherwise by the Owner in writing before the award of contract, based on written request from the bidder for such a clarification.

In the event of conflict between requirements of any two clauses of the specification documents, the more stringent requirements shall apply, unless otherwise confirmed by the Owner in writing before the award of this contract, based on a written request from the Bidder for such clarification.

The Bidders are advised that while making their Bid Proposals and quoting prices, all terms and conditions of bidding documents may appropriately be taken into consideration. Bidders are required to furnish a certificate indicating their full compliance to the terms and conditions of the bidding documents.

3.12 Limit of Contract

Equipment furnished shall be complete in all respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions. All similar standard components/ parts of similar standard equipment provided shall be interchangeable with one another.

This review by the Owner's Engineer / Consultant may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicative of the accuracy of the information submitted. This review and/ or approval by the Engineer shall not be construed by the Bidder, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements specified under these specifications and documents.

3.13 Latent Defects

Notwithstanding the issue of the Take Over Certificate, the Contractor shall be responsible for making good with all possible speed any Latent Defect in any Works /equipment of the plant which appears at any time before the expiry of defect liability period. And shall remedy such defect at its own cost and expense. The latent defect liability period shall be a minimum of 5 years from the end of defect liability period. The defects to which this applies are defects in design, materials or workmanship or defects arising from any act or omission of the Contractor done or omitted prior to Take-over of the portion of the Plant affected by the defects or during the Warranty Period which a reasonable examination at the end of the Warranty Period would not have disclosed.

3.14 Defect Liability

The Contractor warrants that all the facilities or any part thereof are new, unused, and of the most recent or current models, and that they incorporate all recent improvements in design and materials, unless provided otherwise in the Contract.

The Contractor further warrants that the Plant and equipment shall be free from defects arising from any act or omission of the Contractor or arising from design, materials, and workmanship, under normal use in the conditions prevailing in the

If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and equipment supplied or part thereof, the Contractor shall promptly, in consultation and agreement with the Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Contractor shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect. The Contractor shall not be responsible for the repair, replacement or making good of any defect or of any damage to the Facilities arising out of or resulting from any of the following causes:

(a) Improper operation or maintenance of the Plant and equipment by the Employer

(b) Operation of the Facilities outside specifications provided in the Contract

(c) Normal wear and tear.

3.15 Completion Schedule

The Bidder shall submit Time Bar chart indicating completion date of major activities such as submission of design data / calculations and drawings for approval, manufacturing of components / units, supply, inspection etc. without which the Tender shall not be considered. Time Bar Chart furnished shall afterwards form part of the contract and cannot be altered arbitrarily except Force Majeure conditions as may be agreed with the Owner.

3.16 Drawings & Documents for Owner's use and Archives

The Bidder shall submit all final drawings, documents, manuals for Owner's use and for reference / record required during course of operation and maintenance of the plant.

Numbers of copies and their form (hard copy, electronic form, reproducible) to be submitted and the details of the documents, drawings, manual etc. to be furnished by the Bidder are described elsewhere in the specification.

Drawings, documents, calculation, data & Information to be submitted by the Bidder along with the offer:

Technical Data to be submitted with the Tender

1) List of performance tests proposed by the Bidder to demonstrate the guaranteed parameters for generator and other electrical equipment.
2) Specific energy consumption.
3) Type test certificates for major categories of equipment, issued by independent testing authority.
4) Guaranteed Technical Parameters.
5) Technical catalogues.
6) Manufacturing Quality Plan

Operation & Maintenance Manuals

Instruction manuals, presenting the basic categories of information for the operating and/or maintenance personnel, as detailed herein below shall be furnished by Bidder.
The instruction manuals shall present the following basic categories of information in particular complete and comprehensive manner and prepared for the use by operating and/or maintenance personnel.

i. Instructions for initial commissioning, short duration and long duration shut down.
ii. Instruction for operation, routine inspection and maintenance including preventive maintenance.
iii. Recommendation for inspection points, method of inspection and period of inspection.
iv. Information on detection, cause and rectification of troubles and faults.
v. Instructions on normal repairs and overhaul.
vi. Complete parts list with proper and complete identification (Tag nos./Serial nos. as shown in the respective approved drawings) and ordering information for all replaceable parts. The identification details of equivalent and alternative makes for these spare parts which are not manufacturer's own product shall also be listed.
vii. List of all special tools and tackle & spares and instructions for use of such tools and tackle & spares.
viii. One complete set of as built drawings of the entire systems.
ix. The information shall be organized in a logical and orderly sequence. A general description of equipment including significant technical characteristics shall be

included to familiarize operating and maintenance personnel with the equipment. Such description and technical characteristics shall not differ from the approved data.

x. Necessary drawings, curves and other illustrations shall be included or copies of appropriate approved drawings shall be bound in the manuals. Tests, adjustment and calibration information, as appropriate, shall be included. Safety and other warning notices and installation, maintenance and operating cautions shall be emphasized.

xi. Write-up, figures, part list etc., shall be clearly legible. The manuals shall be prepared on good quality paper securely bound in durable folders.

xii. The instruction manuals shall be subject to Consultant's approval in the same fashion as that for drawings.

xiii. Instruction manual shall give step by step procedure for Erection, testing and commissioning

xiv. Operation, Maintenance and Repair Instruction manual shall also contain:

xv. List of spare parts with ordering specifications and manufacturer's catalogues

xvi. List of consumables, lubricants, chemicals with specifications, brand names and annual consumption figures.

xvii. Drawings relevant for erection, operation, maintenance and repair of the equipment.

xviii. Procedure for ordering spares.

xix. Maintenance Manual shall also include:

xx. Diagnostic trouble shooting / fault location charts

xxi. Tests for checking of proper functioning.

Drawings / documents for approval

Quality Control & Quality Assurance plan.

G.A. and Cross Sectional drawings of all equipment indicating weights, material of construction, bill of material, dimension, specification etc.

Final design calculations and assumptions.

Actual performance data and characteristic curves based on the testing at site.

Technical specification of all equipment, motors, for all system and all other accessories.

Final list of drawings.

As built drawings.

Miscellaneous

i. General arrangement and cross sectional drawings of all major components with bill of material.

ii. Foundation drawings, load data & design calculation for all equipment.

iii. Erection drawings for all equipment and structures showing complete erection details.

iv. Engineering and design calculations of installations and units.

v. QAPs

vi. Detailed procedures of shop testing of all the items applicable shall be submitted to the Owner/ Consultant for approval before conducting tests.

vii. Following shop test certificates/test curves/data, shall be furnished.

- Materials and components test certificates.
- Performance test results and characteristic curves of all fans, pumps, and electric drive motors etc.
- Non-destructive test results as applicable.
- Reports and test certificates of shop tests.
- Type test & routine test certificates.

viii. Detailed quality assurance program along with quality plan shall be submitted.

Following data shall be furnished:-

a) Technical data of all the plant, equipment, drive motors, instruments, panels, etc. shall be furnished.

b) Following lists/tables / write ups shall be furnished, complete with tag nos. and brief specification. Proper numbering system as approved by Consultant/Owner shall be adopted.

i) Instrument schedule (with service, range, make of instrument).
ii) Flow element schedule.
iii) Valve schedule.
iv) Pipe schedule.
v) Cable schedule (Power & Control).
vi) Schedule of actuators (electric/pneumatic)

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Employer would be discussed and finalized at the time of award. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer.

Note: The contractor may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

3.17 Workmanship and Quality Control

All moving parts of equipment, which can conceivably cause injury to the operator and otherwise authorized personnel within the vicinity of working area shall be suitably guarded and warning displays shall be put at prominent places.

The Bidder shall clearly indicate and identify the plans and procedures, which shall be followed in the design, manufacture and installation of plant and equipment to control and assure to the Owner of the desired quality.

FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

3.17.1 Equipment Mounting

All instruments, switches etc. mounted on the front face of the panels shall be of flush type.

All equipment shall be so mounted that removal and replacement may be accomplished individually without interruption of service to others.

All equipment inside the panel shall be so located that their terminals and adjustments are readily accessible for inspection and maintenance. Adequate ventilation shall be provided in enclosed panel.

Each of the LV switchboards shall be designed for 1.1 times the required rating as a spare capacity. Further all LV Switchboard shall be provided with 20 % spare modules of each rating and type of module.

3.18 Title Block :

Project	4x225MW Arun-3 (HEP),Nepal			
Customer	SJVN Arun-3 Power Development Company (P) Ltd. (SAPDC)			
Consultant	SJVN Ltd			
	BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA		Name	Sign
		Drawn		
		Checked		
		Approved		
Title		Drawing Number :		**Rev**

----------xxxx----------

SECTION-4
ENCLOSURES TO SPECIFICATION

SCHEDULES TO BE FILLED UP BY THE BIDDER

Schedule 1 **Schedule of Recommended Spares**

Schedule 2 **Schedule of Makes of Equipments**

Schedule 3 **Schedules of Deviations**

Schedule 4 **Schedule of past experience and qualifying requirements**

Schedule 5 **Schedule of performance certificates**

Schedule 6 **Schedule of type test and special tests**

Schedule 7 **Details of contact persons (technical & commercial)**

Schedule 8 **Enclosures to Specification**

SCHEDULE-1

SCHEDULE OF RECOMMENDED SPARES

S.No.	Description	Quantity

Place

Date

Signature of the authorized representative of Bidder

Name ----------

Designation----------

Company seal----------

SCHEDULE-2

MAKES OF IMPORTANT ITEMS / COMPONENTS OF EQUIPMENTS AND THEIR DETAILS

ITEM NAME	NAME OF MANUFACTURER	PLACE OF MANUFACTURE OF ITEM	PLACE OF TESTING AND INSPECTION	COMPLIANCE WITH ISO 9001 (YES/NO)

Place

Date

Signature of the authorized representative of Bidder

Name ----------

Designation----------

Company seal----------

SCHEDULE-3

SCHEDULE OF TECHNICAL DEVIATION

The following are the deviations / variations / exceptions from the specification:

Section	Clause No. / Page No.	Statement of deviation/ Variations/Exceptions

1) In case, this schedule is not submitted, it will be presumed that the equipment /material to be supplied under this contract are deemed to be in compliance with the specification.

2) If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**

3) Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

Place

Date

Signature of the authorized representative of Bidder

Name ----------

Designation----------

Company seal----------

SCHEDULE – 4

SCHEDULE OF PAST EXPERIENCE AND QUALIFYING REQUIREMENT

Following is the list of earlier orders executed by us for supply of equipment / material of similar nature over the last past five years:

S.No.	Item	Brief rating	Qty	customer	Date Of order	Date of supply	Order value

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

SCHEDULE – 5

SCHEDULE OF PERFORMANCE CERTIFICATE

Bidder shall furnish the performance certificate of the similar equipment having
The following details:

S.No.	Item	Brief rating	Qty	Customer	Date Of supply

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

SCHEDULE-6

SCHEDULE OF TYPE TESTS AND SPECIAL TESTS

The following type tests and special tests as called for in the Specification shall be conducted (all type tests / special tests as mentioned in the relevant clauses of the Specification shall be listed here):

Sl no.	Clause no/ page no of Specification	Details of test	Lab in which to be conducted	Whether test to be conducted free or on chargeable basis. Mention 'FREE' or 'CHARGEABLE'	If charges per test have been quoted for in the price bid. YES / NO
		A. Type Tests			
		1.			
		2.			
		B. Routine Tests			**DO NOT**
		1.			**MENTION**
		2.			**ANY PRICE**
		C. Site Tests			**IN THIS**
		1.			**COLUMN**
		2.			
		D. Special Tests (specified)			
		1.			
		2.			
		E. Other tests at works / site recommended by the Bidder			
		1.			
		2.			

NOTE:

1) Details have to be furnished on cables as well as accessories, each separately.

2) NO PRICE SHALL BE FURNISHED IN THIS FORMAT.

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal----------

SCHEDULE-7

DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL

Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

SCHEDULE –8

ENCLOSURES TO SPECIFICATION

ANNEXURES

1. Manufacturing Quality Test Assurance Requirements
2. Field Quality Test Assurance Requirements
3. Export worthy Packing
4. Quality and Inspection Formats

DRAWINGS

1. ***TB-3-405-316-020, R03: Layout of GIS Building of 4x225MW Arun-3 HEP***

Manufacturing Quality Assurance Test Requirements

Project Name: Arun - 3 HEP (4x225 MW)	**Doc. No.** QAI/A/M/EM/EOT/01	**Rev. No.** 02
Item Description: EOT Crane	**Issue Date:** 30.05.17	**Pages : 3**

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

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

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

LEGENDS

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

NOTES

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

Field Quality Assurance Test Requirements

Project Name: Arun - 3 HEP (4X225 MW)	**Doc. No.** QAI/A/F/EM/EOT/01	**Rev. No.** 02
Item Description: EOT Crane	**Issue Date:** 30.05.17	**Pages: 2**

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
	EOT CRANE		
1	**Receipt of Material**		
	External conditions of Equipment free from Damages etc	Packing list/DRG/ Tech Spec.	W*
	Number of packages in each Equipment and physical condition of each package	Packing list /DRG /Tech Spec.	W*
2	**Storage**		
	Proper Placement of equipment as per the Instruction Manual.	All parts fully covered	W*
	Ensure that no damage or rusting takes place during storage	All parts fully covered	W*
	Ensure that all delicate Equipment are stored in protected area.	All parts fully covered	W*
3	**Pre-erection & erection check**		
3.1	**Site Welding**		
	Joint preparation, edge preparation & root gap	DRG/TS/ASME V & VIII	W*
	NDT	DRG/TS/ASME V & VIII	W*
	Visual check	DRG/TS/ASME V & VIII	W*
3.2	**Embedments / Sole Plates**		
	Installation/fixing of embedments as per drawing.	DRG/TS/Plant std	W*
	Leveling & alignment before & after concreting.	DRG/TS/Plant std	W*
3.3	**Blockout**		
	Check for visual, dimensions & Co-ordinates of block out	DRG/TS/Plant std	W*
3.4	Gantry Girder level, diagonal, head room height, side clearance etc.	DRG/TS/Plant std	W*
3.5	**Rail**		
	Centre distance measure at every 6 Mtr. Length.	DRG/TS/Plant std	W*
	Measurement of Rail centre distance at every 6 mtr. Length, Diagonal, straightness of each rail.	DRG/TS/Plant std	W*
	Verification of expansion gap within rail w.r.t. civil drawing.	DRG/TS/Plant std	W*
	Tightening of rail clamps (LT Rail).	DRG/TS/Plant std	W*
	Waviness of rail (horizontal and vertical planes).	DRG/TS/Plant std	W*
3.6	**Erection of end carriage**		
	Free movement of wheel over rail.All wheels in contact with L.T.Rail.	DRG/TS/Plant std	W*
3.7	**Erection of girders & joint with end carriage / Bogie.**		
	Matching of fastener holes for joint E/C & Girder for joining bogies with girder.	DRG/TS/Plant std	W*
	Check span both drive and idle side.	DRG/TS/Plant std	W*
	Check Diagonal Dist. Over L.T. Wheels.	DRG/TS/Plant std	W*
3.8	**Fixing crab on CT Rail (Girder Rails)**		
	Alignment of CT mechanism.	DRG/TS/Plant std	W*
	Alignment of MH & AH mechanism.	DRG/TS/Plant std	W*
3.9	**Rope Waving, Hook Block Fixing.**		
	Free movement of hook, Head Room	DRG/TS/Plant std	W*
3.10.	**Electrification and cabling**		
	Check L.T., C.T., Hoist Motions for proper electrical work.	DRG/TS/Plant std	W*
3.11	**Erection of DSL, if applicable**		
	Check for straightness, level, alignment with respect to gantry rails, fixing arrangement, painting.	DRG/TS/Plant std	W*
4	**Pre-commissioning & commissioning check**		
4.1	**De-energized test**		
	De-energized test shall be carried out as per TS.	App Drg. / IS: 3177/TS	W*
4.2	**No Load Static Test**		
	Checking of gears, bearings, couplings and rotating parts for proper oil level or lubrication and hydraulic brakes for brake fluid.	App Drg. / IS: 3177/TS	W*
	Checking of satisfactory operation and to determine if lamp fixture on each bridge walk way are operable and convenient for re-lamping.	App Drg. / IS: 3177/TS	W*
	Checking of the controller for each motion to ensure that hook and travel motions is in accordance with marked controller directions.	App Drg. / IS: 3177/TS	W*
	Overall inspection & verification of crane dimensions, clearances, hook reaches & other important items.	App Drg. / IS: 3177/TS	W*
	Verification of insulation resistance for electrical equipment and wiring circuits	App Drg. / IS: 3177/TS	W*
	Operational tests on each controller, switch, contactor, relay and other control devices including limit switches.	App Drg. / IS: 3177/TS/Plant STD	W*
	Operational tests on all protective devices.	App Drg. / IS: 3177/TS/Plant STD	W*

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
	Test for checking correctness of all circuits, interlocks, and sequences of operation.	App Drg. / IS: 3177/TS/Plant STD	W*
	Check of drift point for smooth and effective operation.	App Drg. / IS: 3177/TS/Plant STD	W*
	Tightness of nuts and bolts	App Drg. / IS: 3177/TS/Plant STD	W*
	Measurement of throat opening of hook & checking w.r.t dimensions provided by supplier.	App Drg. / IS: 3177/ TS/Plant STD	W*
	Check all Brake setting.	App Drg. / IS: 3177/TS	W*
	Check oil leakage in all gear Boxes.	App Drg. / IS: 3177/TS	W*
4.3	**No Load operation tests.**		
	No Load operation tests shall be carried out as per technical Specification.	App Drg. / IS: 3177/TS	W*
	Measure current for all motions. Emergency stop test (Switch off, emergency off).	App Drg. / IS: 3177/TS	W*
4.4	**Load Test (at rated load).**		
	Load test (at SWL) shall be carried out as per Technical Specification.	App Drg. / IS: 3177/TS	W*
	Measure speed and current for all motions.	App Drg. / IS: 3177/TS	W*
	Measurement of defection at SWL.	App Drg. / IS: 3177/TS	W*
4.5	**Over load Test**		W*
	Over load test shall be carried out as per Technical Specification.	App Drg. / IS: 3177/TS	W*
	Check bridge structure for excessive deflection at 125% of rated load.	App Drg. / IS: 3177/TS	W*
	Braking test at overload.	App Drg. / IS: 3177/TS	W*
	Measurement of throat opening of hook.	App Drg. / IS: 3177/TS	W*
4.6	**Commissioning**		
	Check trouble Free running of crane Set right wherever any trouble.	App Drg. / IS: 3177/TS	W*
4.7	**Tandem operation test for power house crane including anti-collision test.**		
	Electrical & Mechanical interlock checking.	App Drg. / IS: 3177/TS	W*
	Movement checking with tandem beam.	App Drg. / IS: 3177/TS	W*
4.8	**Performance test**		
	Performance test shall be carried out as per TS.	App Drg. / IS: 3177/TS	W*
4.9	**Load Frames / cradle**		
	Tests on load frame / cradle shall be carried out as per TS.	App Drg. / IS: 3177/TS	W*
4.10.	**Paint touch up:** Paint applied all over crane parts.	App Drg. / IS: 3177/TS	W*

LEGENDS

TS: TECHNICAL SPECIFICATION	REL. STD.: RELEVANT STANDARD
V: VERIFICATION OF REPORTS/TCs	DRG: DRAWING
W: CUSTOMER HOLD POINT (CHP)	W*: WITNESS BY SAPDC / MAIN CONTRACTOR

NOTES

1	Any test at any stage not covered in Quality Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification.
3	Responsibility for witnessing (W*) at site shall be finalized mutually at the time of finalization of FQAP as per the criticality of test.

1.0 SCOPE:

For export jobs, sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy periods of outdoor storage in adverse weather conditions are required. Workmanship and material used shall meet the technical requirements and be in accordance with best commercial export packing practices. Vendor shall be responsible for the packing, however, it shall meet the minimum requirements specified herein. Equivalent or better packing methods may be deployed subject to approval of the purchaser. Vendor shall submit the packing procedure for its equipment for purchaser's approval during detailed engineering.

2.0 TECHNICAL SPECIFICATION OF WOOD:

The wood shall be Fir, Chir, Silver Oak (Grevillea Robusta) or chemically treated mango with moisture content not exceeding 50 %. The wood shall have flextural & compressive strength, stiffness, shock absorption and nail retention properties. The wood shall be free from common defects such as warp, bone, twist, knot, cracks, splits, end splits, bend, visible sign of infection and any kind of decay caused by insects, fungus etc. Surface cracks with a maximum depth of 3 mm are permissible. A continuous crack of any depth all along the length is not allowed.

The wood shall be chemically treated to provide protection against deterioration due to fungi and attack by termites, borers, marine organism and any other kind of infection. It shall be treated only after final processing like cutting, planing, joint grooving etc.

3.0 TYPE, DESIGN & DIMENSION OF WOODEN PACKING CASES:

3.1.1 PACKING OF EQUIPMENTS:

Various mechanical, electrical and C&I equipment e.g. pumps, motors, equipment skids, heat exchangers, control panels, switch gears, transformers etc. shall be wrapped in weather proof packing and then secured in wooden packing cases. The construction of wooden packing cases shall be as per details given below and also in figures 1 to 11.

3.1.1 BOTTOM FRAME:

The construction of bottom frame shall be as per fig. 2. The number of slides/runners for bottom frames shall be selected depending upon the weight and overall dimension of the load to be carried. The equipment shall be secured by fixing their base frame/plate with the help of bolt & nuts etc to the bottom frame of the wooden packing cases. The equipment not provided with the base frame/plate like

cylindrical vessels etc. to be secured to the bottom frame of the wooden case with ‘C’ clamps fabricated from steel channels/angle irons.

3.1.2 TOP FRAME:

The construction of top frame shall be as per fig. 3.

3.1.3 END PANELS:

The dimensions of the end and lateral panels shall be calculated according to overall dimensions of the items to be packed.

Diagonal braces shall be used for packing cases having height exceeding 500 mm. Detail of bracing shall be as per figure 5 to 8.

3.1.4 SLING PLATE:

To facilitate lifting of cases, longitudnal under slide boards shall be fixed. To avoid damage to the box while lifting sling plates shall be provided. Refer fig. 11.

3.1.5 ANGLE IRON CLEATS :

Angle iron cleats shall be used for strengthening the joints as indicated in fig. 10.

3.1.6 OTHER REQUIREMENTS:

The thickness of planks for top, bottom, side and end panels shall be atleast 25 mm. Planks used for this purpose shall be joined with each other by tongue & groove joint. The groove dimension shall be such that tongue fits tightly into groove to make good joint.

Runners/slides, traverse bars etc. shall be of single length i.e. without any joint. Planks for sheathing, diagonal bracing etc shall also be of single length upto 2400 mm. For sizes larger than 2400 mm, proper jointing is permitted for planks for sheathing and diagonal bracing.

Each equipment to be individually covered with double polyethylene petticoat. Sheet thickness of polyethylene sheet shall not be less than 0.175 mm (175 microns). The sealing shall be such so as not to allow moisture inside.

The inner surface of 4 sides of shooks shall be nailed with bituminised water proof kraft paper. Whereever 2 pieces of kraft paper are used, the joint shall have an overlap of minimum 20mm.

All the inner sides of the box shall be nailed with bitumen coated hessian polyethylene kraft paper. For top frame it shall project on all sides by 100mm and shall be nailed on sides. Wherever 2 pieces of kraft paper are used, the joint shall have an overlap of minimum 20mm.

For delicate equipment like control panels, switchgears etc suitable cushioning material like rubberized coir shall be provided on their bottom support. The thickness of coir shall be 50 mm (minimum) and width 100 mm (minimum).

For control panels and switchgears, the gap between the panel and casing shall be filled with rubberized coir with distance between consecutive supports less than 500 mm (ref fig 15). For other equipment suitable support from sides of the casing to be provided.

Switchgear cubicles, control panels and control desks shall be packed and shipped in separate convenient sections. The components e.g. circuit breakers relays and instruments etc. which are removed from panels for shipping purpose shall be separately packed and shipped as per packing instructions in clause 3.2.

Packing case for control panels & switchgear panels shall be finally covered with GI sheet of minimum thickness of 0.4 mm.

Packing cases shall be bound at edges by nailing MS clamps/brackets at sufficient intervals. Further, heavier boxes shall be strapped with 'C' clamps (ref fig 4) fabricated from steel channels/angles and lighter boxes shall be strapped with hoop iron strips.

3.1.7 ALTERNATIVE PACKING CASES FOR CONTROL PANELS AND SWITCHGEARS

If required, for control and switchgear panels, construction of wooden packing cases may be provided as per fig 14 & 15 and as detailed below:

Thickness of planks for all sides, binding and jointing battens shall be atleast 25 mm. Width of planks shall be at least 125mm and that of binding and jointing planks shall be at least 100 mm.

Top frame shall be suitable so that it does not collapse due to sandwitching between slings while lifting. Longitudnal and traverse bars for the bottom wooden pallet to be suitably selected.

Diagonal bracings shall be as per clause 3.1.3 and All other requirements shall be as per clauses 3.1.4 to 3.1.6.

3.2 PACKING OF LOOSE ITEMS:

Loose mechanical, electrical and C&I items eg valves, fittings, pressure/temperature gauges/switches, circuit breakers, relays etc shall be individually wrapped using polyethylene sheets/U foam/thermocole sheets/air bubbled sheets depending upon the item and then packed in wooden boxes. The left out spaces and top of the boxes shall be filled with rubberized coir to get proper cushioning effect. Special attention is to be paid to relays, instruments etc for arresting the movement of their operating mechanisms during transportation.

The construction of wooden packing case shall be as per clause 3.1 retaining its all features concerning strength of box. The construction of wooden packing case for loose electrical and C&I items shall be as per fig. 16.

Inner surface of 6 sides of the box shall be lined with Bitumen coated hessian polyethylene kraft paper. Rubberized coir of min. 25 mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of the box.

Loose items such as Galvanised Steel Structure, Cable support racks, Cable Trays and GI Pipes etc. shall be individually wrapped using polyethylene sheets and further lots may be wrapped in Bitumen coated hessian cloth.

4.0 MOISTURE ABSORBER:

Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be of indicating type conforming to IS-304-1979 packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come directly into contact with the equipment / material inside the package. The quantity of silica gel shall be enough for storage period of one (1) year, however, it shall not be less than 4 gms per litre volume of case subject to minimum of 400 gms per case.

5.0 INDICATION MARKS ON THE BOXES:

Markings shall be provided on the boxes indicating position of boxes for handling, storage and nature of consignment. For guidelines refer figure 12. The ink used for this purpose as well as for marking despatch instruction shall be indelible/nonwashable marking ink.

6.0 DESPATCH DETAILS:

External front and rear sides of the boxes to be planed for writing instructions.

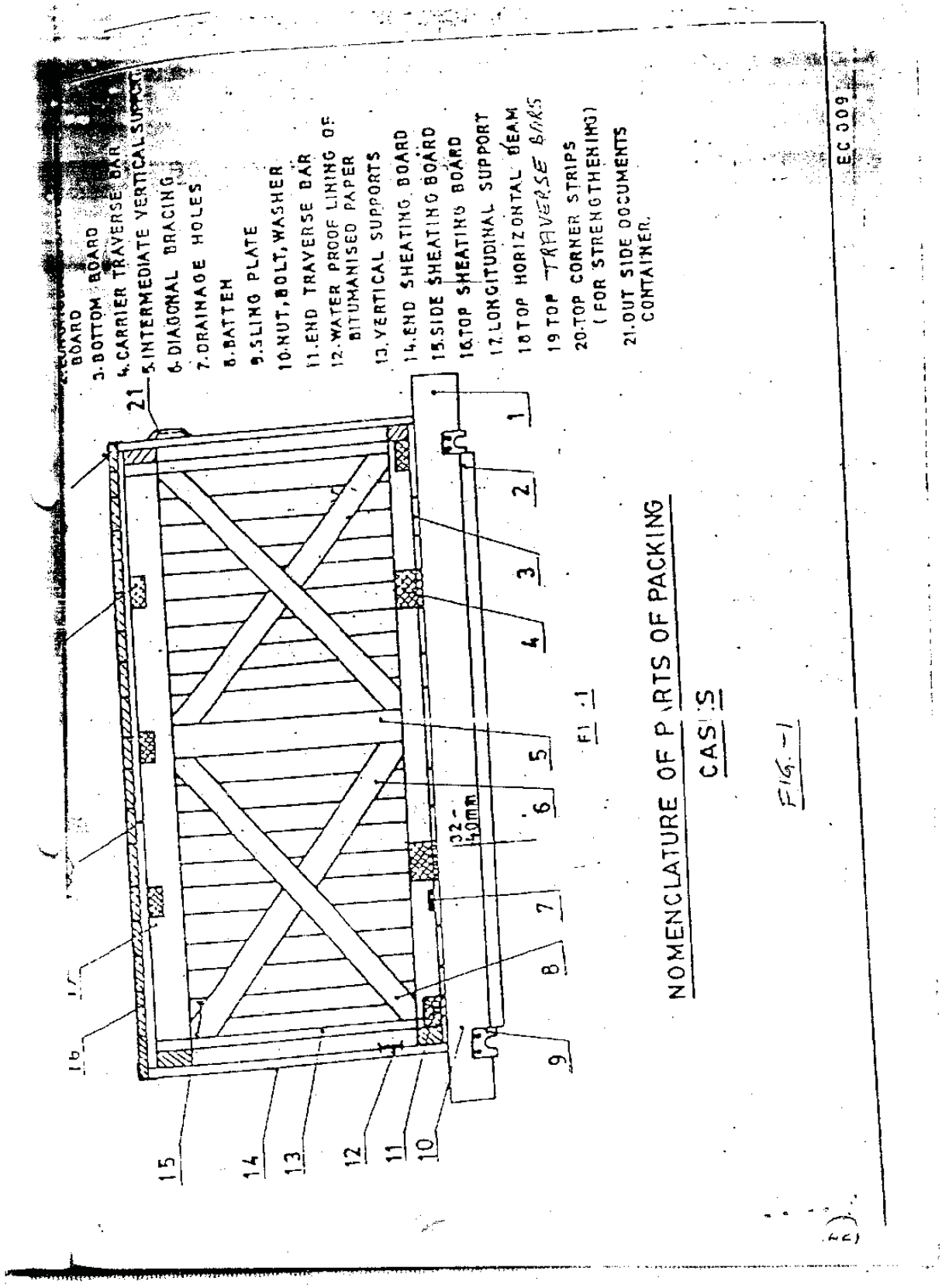
Dispatch details such as consignor/consignee address, contract and case details, country of origin , port of delivery, stacking instructions shall be written on one of the side of boxes. An anodised aluminium plate shall be provided on one side of the boxes.

One copy of packing slip wrapped in polyethylene bag covered with aluminium packing slip holder to be nailed on the external surface of the box. One more copy of the packing slip wrapped in polyethylene bag to be kept inside the box at the prominent place.

7.0 INSPECTION:

There shall be a Customer Hold Point (CHP) for inspection of final assembly of packing. During above inspection, the records for Chemical Treatment shall be reviewed.

- - x x - -


BOARD
3. BOTTOM BOARD
4. CARRIER TRAVERSE BAR
5. INTERMEDIATE VERTICAL SUPPORT
6. DIAGONAL BRACING
7. DRAINAGE HOLES
8. BATTEN
9. SLING PLATE
10. NUT, BOLT, WASHER
11. END TRAVERSE BAR
12. WATER PROOF LINING OF BITUMANISED PAPER
13. VERTICAL SUPPORTS
14. END SHEATING BOARD
15. SIDE SHEATING BOARD
16. TOP SHEATING BOARD
17. LONGITUDINAL SUPPORT
18 TOP HORIZONTAL BEAM
19 TOP TRAVERSE BARS
20. TOP CORNER STRIPS (FOR STRENGTHENING)
21. OUT SIDE DOCUMENTS CONTAINER.
EC 009
32-40mm
NOMENCLATURE OF PARTS OF PACKING CASES
FIG. -1

BOTTOM FRAME ARRANGEMENTS

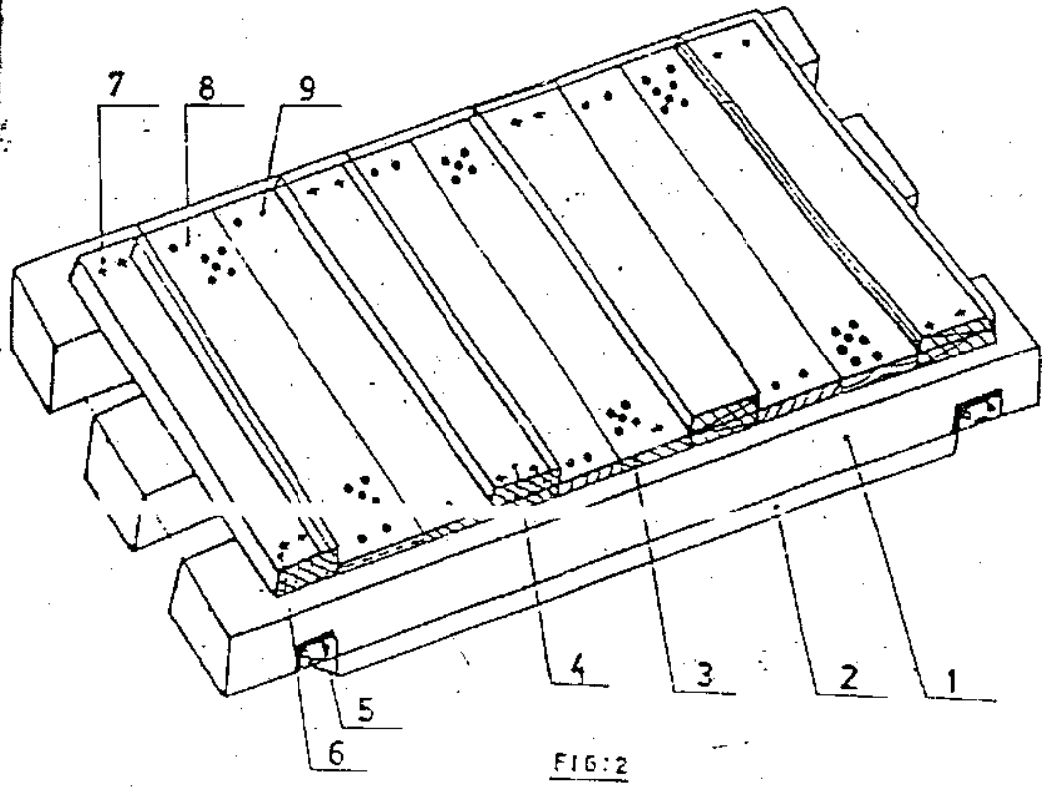


FIG:2

Nos. of slides : Minimum 2 Nos.
For length more than 1800 mm or load more than 1000 kg, Nos. of slides shall be minimum 3 Nos.
For dimensions of slides, refer Table 1
Cross section of end traverse bar; 100 x 100 mm (minimum)

1. SLIDE
2. UNDER SLIDE BOARD
3. BOTTOM BOARD
4. CARRIER TAVERSE BAR
5. SLING PLATE
6. TRAVERSE BAR (END)
7. BOLT, NUT & WASHER
8. DRAINAGE HOLES
9. NAILS

TOP FRAME ARRANGEMENT

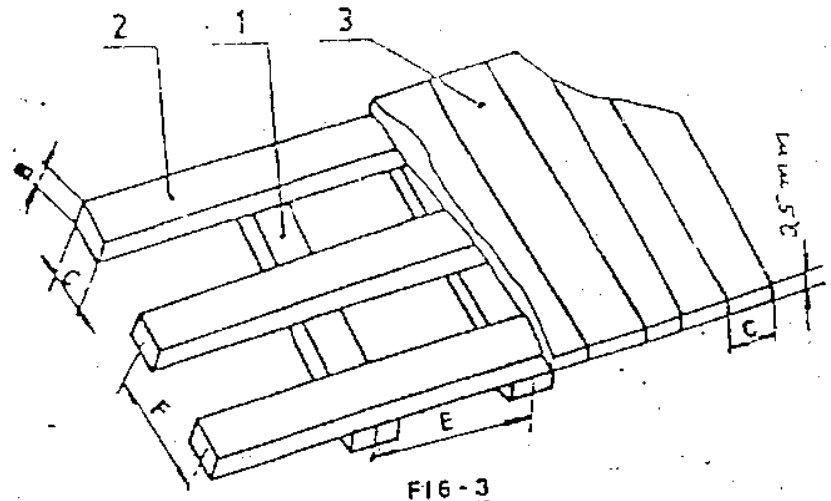
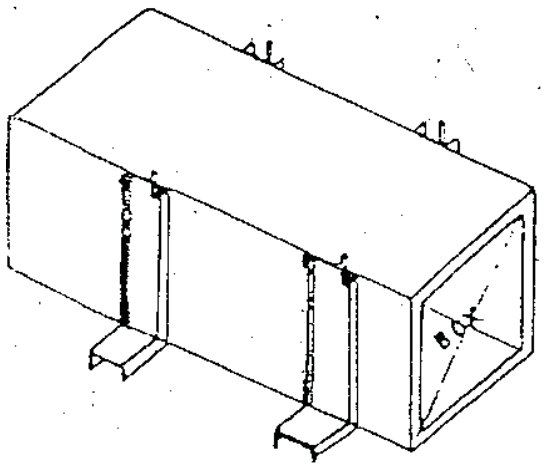


FIG-3

Dim F : 700 to 1000 mm
Dim E : 500 to 900 mm
B x C : 30 x 100 mm.

1 – Traverse Bars
2 – Horizontal Beams
3 – Top Board

ARRANGEMENT OF C-CLAMPS AROUND CASES



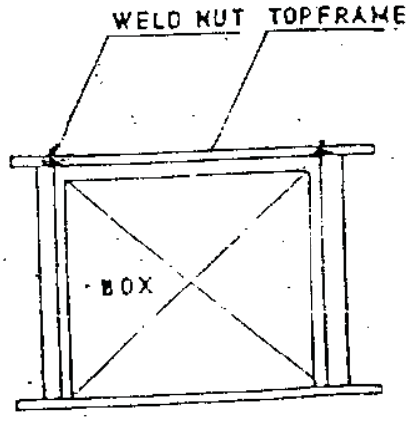


FIG: 4

ARRANGEMENT OF DIAGONAL BRACING AND HORIZONTAL SUPPORT

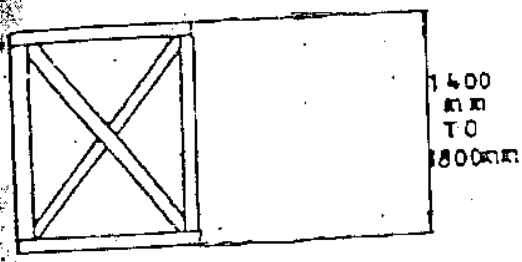


FIG:6

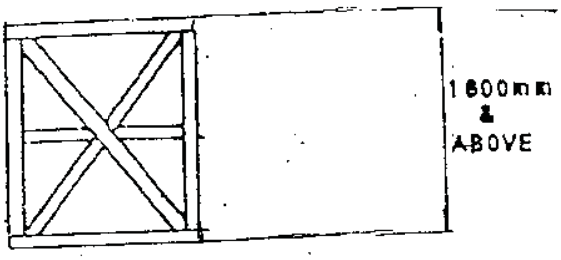


FIG:8

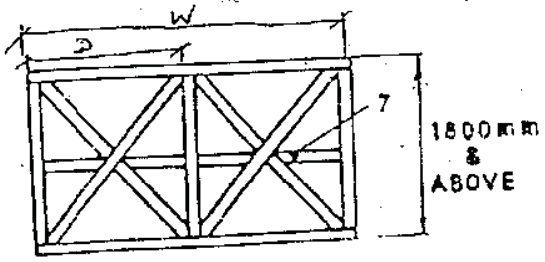


FIG:9

7- Middle Horizontal Support

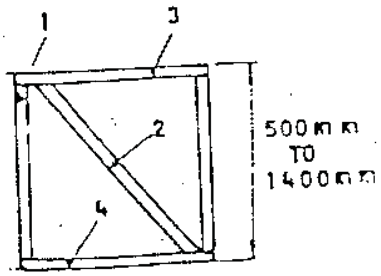


FIG:5

1- Vertical Support
2- Diagonal Bracing
3- Upper Horizontal Support
4- Lower Horizontal Support

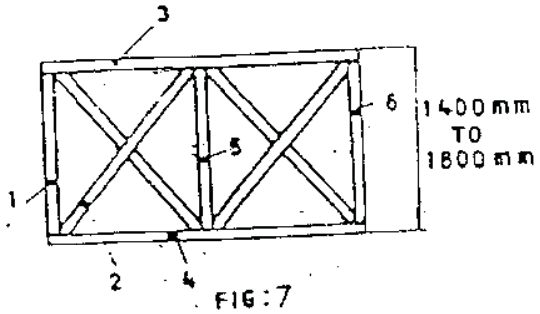
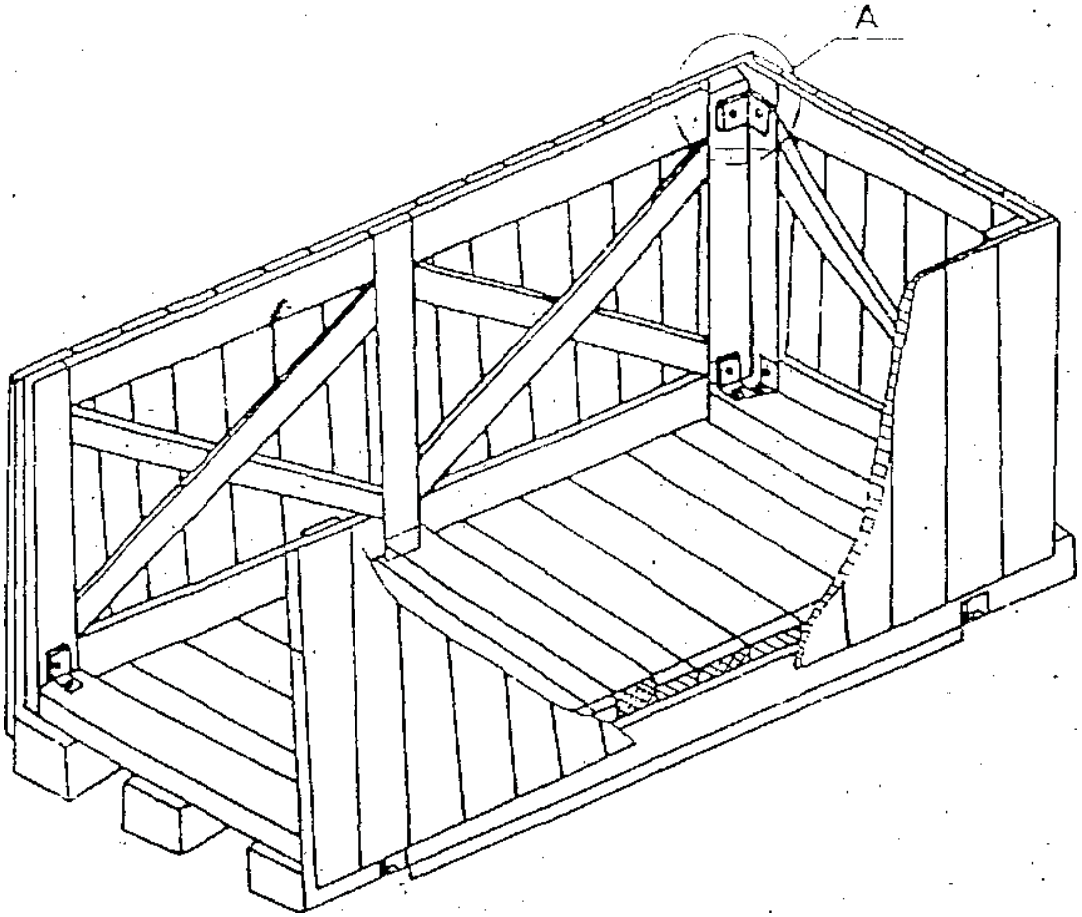


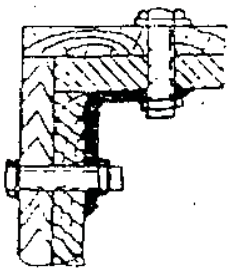
FIG:7

1, 5, 6 - Vertical Support
2 - Diagonal Bracing
3 - Upper Horizontal Support
4 - Lower Horizontal Support

The dimensions of various items shall be as Table-2

ARRANGEMENT OF PACKING CASE





DETAIL-A

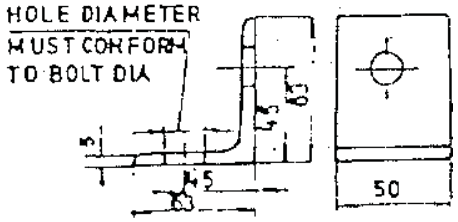


FIG:10

ARRANGEMENT OF SLING - PLATE ON CASES

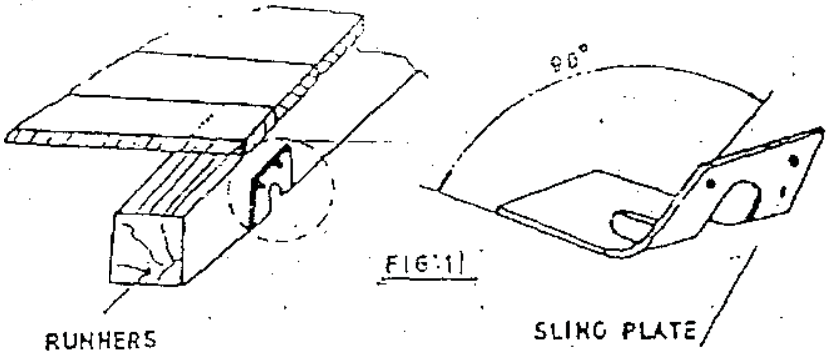


FIG:1

Table 1

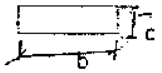
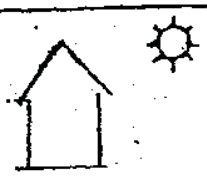
Load	Length of Slides 600	800	1000	1200	1300	1500	2000
	Cross Section b x c 						
500	50 x 100	50 x 100	50 x 100	50 x 100	75 x 100	75 x 100	100 x 100
800	50 x 100	50 x 100	75 x 100	75 x 100	75 x 100	75 x 100	100 x 100
1000	75 x 100	75 x 100	75 x 100	100 x 100	100 x 100	100 x 110	100 x 150
1500	75 x 100	75 x 100	100 x 100	100 x 100	100 x 100	100 x 150	100 x 150
2000	75 x 100	100 x 100	100 x 100	100 x 150	100 x 150	100 x 150	150 x 150
2500	75 x 100	100 x 100	100 x 150	100 x 150	100 x 150	150 x 150	150 x 150
3000	100 x 100	100 x 150	150 x 150	150 x 150	150 x 150	150 x 150	

Table 2

End and side Panels	Width of the panel W	Distance between longitudinal support DIM 'D'						
		600	800	1000	1200	1400	1600	1800
		Cross Section (b : c) Item 1 to 7						
Fig 5	600 to 1200	30 x 100	30 x 100	30 x 100	30 x 130	30 x 130	30 x 130	30 x 130
to	1201 to 1600	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130
	1601 to 2000	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130
Fig 9	2001 to 3000	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130	30 x 130	40 x 150
	3001 to 4000	30 x 130	30 x 130	40 x 150	40 x 150	40 x 150	40 x 150	40 x 150

INDICATION MARKS ON CASES

SL NO	INDICATION MARK	MEANING
1		TOP SIDE
2		KEEP AWAY FROM HEAT
3		SLINGING POSITION
4		FRAGILE MATERIAL TO BE HANDLED WITH CARE
5		CENTRE OF GRAVITY
6		KEEP DRY

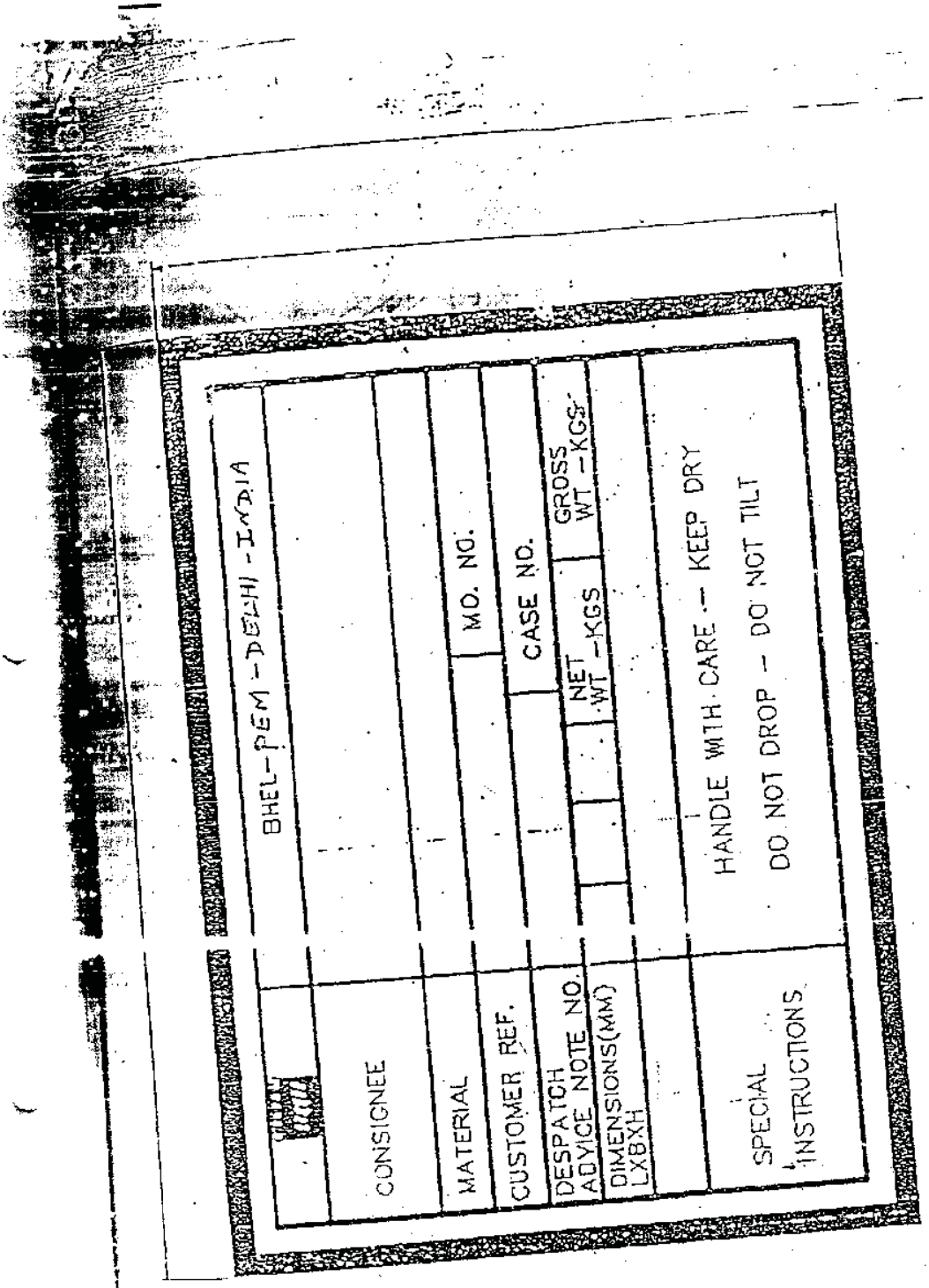


FIG-13: MARKING PLATE.

(31)

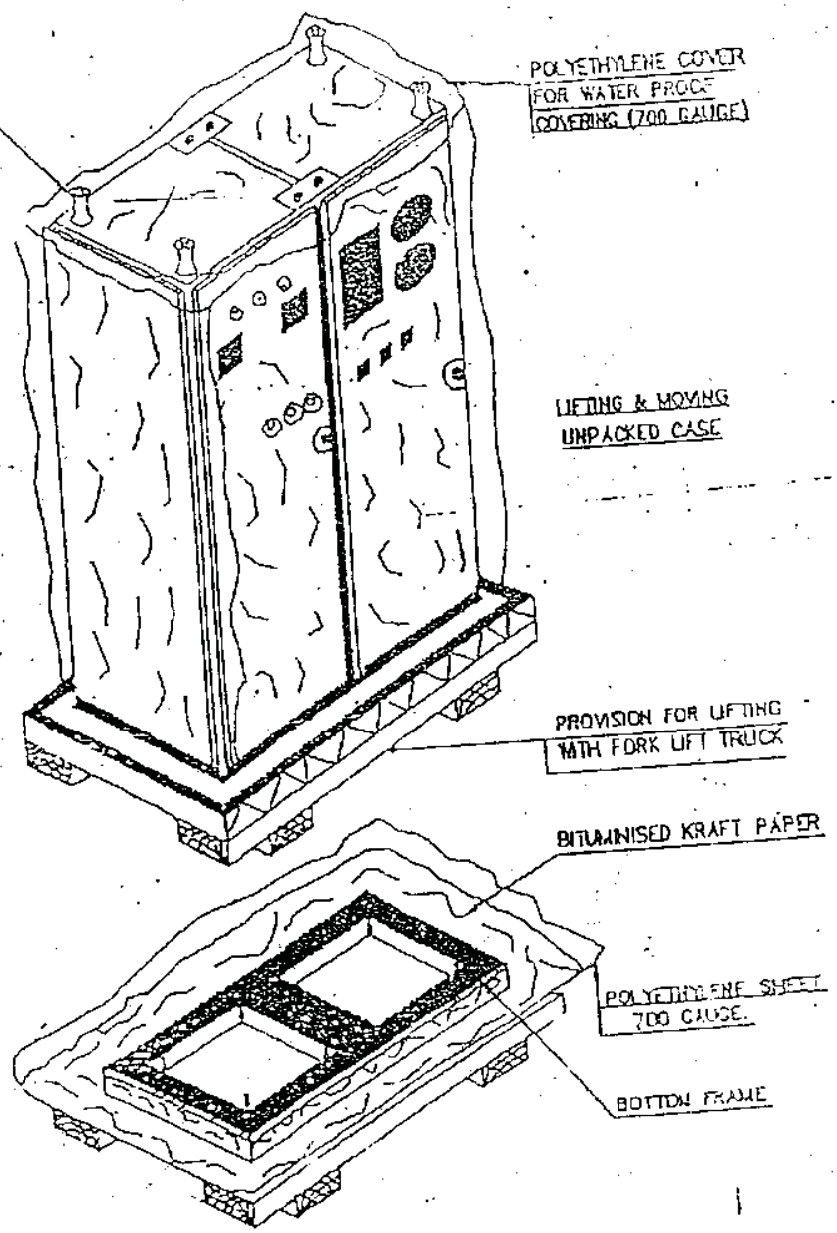
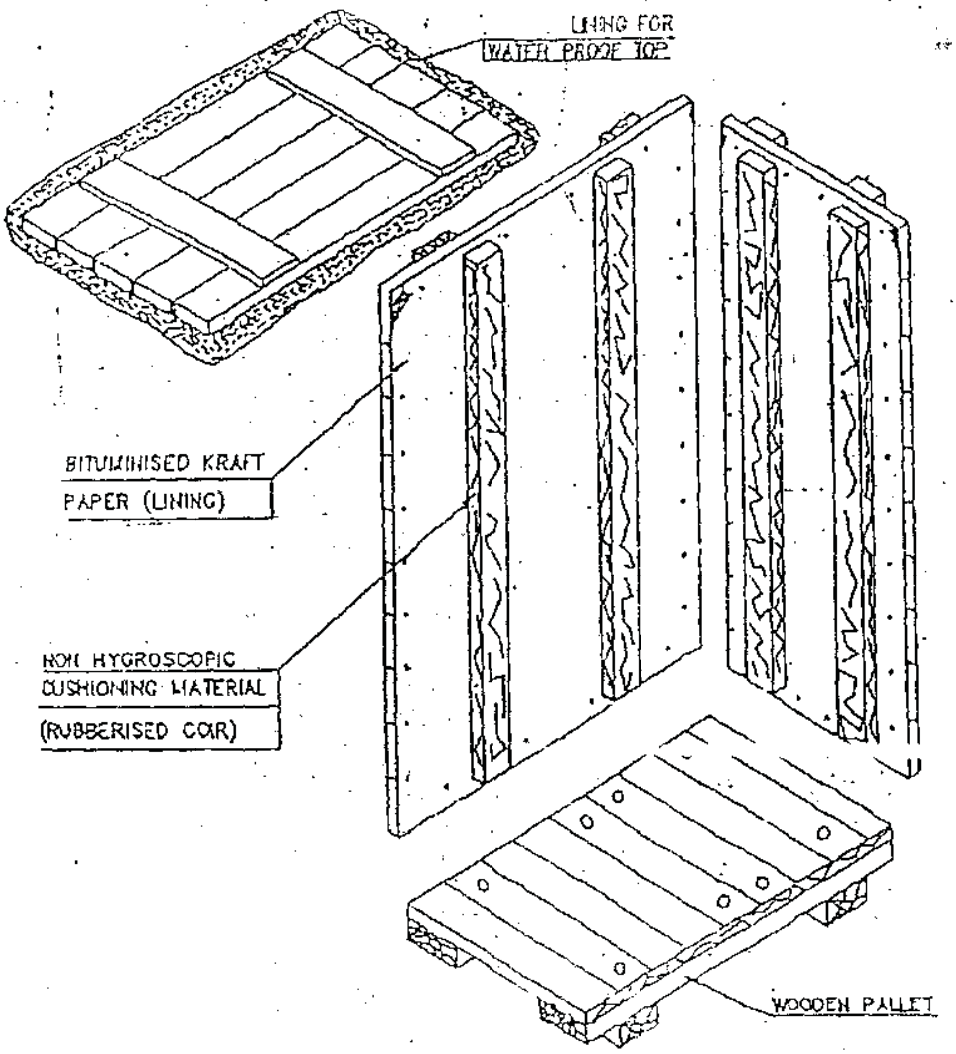

EYE BOLT
POLYETHYLENE COVER FOR WATER PROOF COVERING (700 GAUGE)
LIFTING & MOVING UNPACKED CASE
PROVISION FOR LIFTING WITH FORK LIFT TRUCK
BITUMINISED KRAFT PAPER
POLYETHYLENE SHEET 700 GAUGE.
BOTTOM FRAME

FIGURE-14


LINING FOR
WATER PROOF TOP
BITUMINISED KRAFT
PAPER (LINING)
NON HYGROSCOPIC
CUSHIONING MATERIAL
(RUBBERISED COIR)
WOODEN PALLET

FIGURE–15

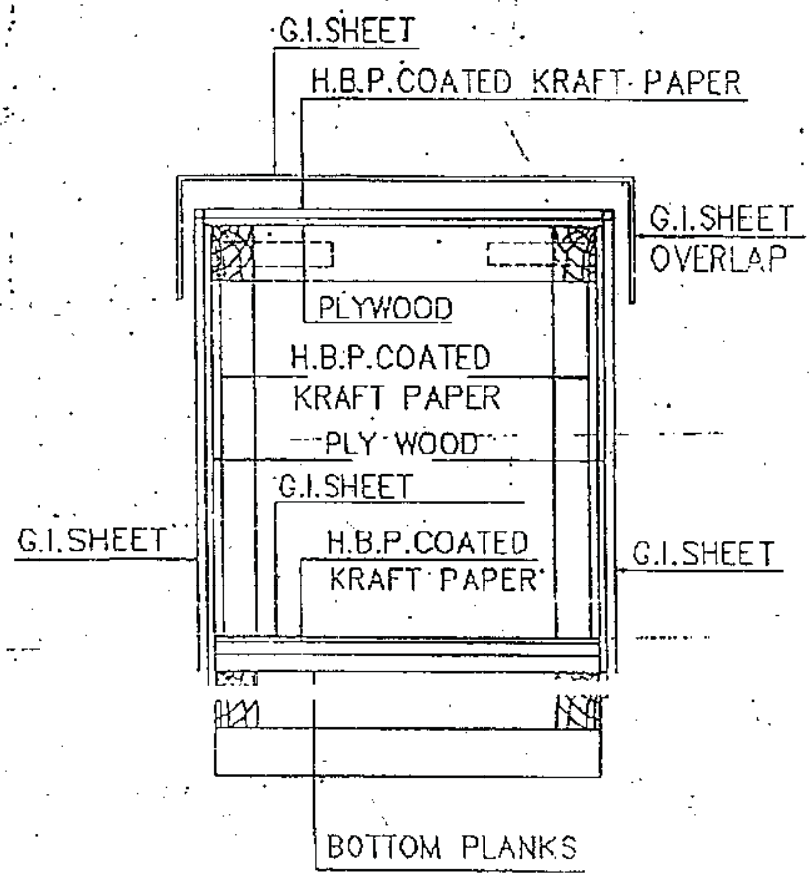


FIG-16 : CLOSED PACKING CASE WITH G.I.SHEET SHOWING LAYERS OF PACKING MATERIALS.

Annexure –E

QA&I Formats

SJVN	FORM NO.: F-060-01 PAGE: 1 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

VENDOR / SUB-VENDOR ASSESSMENT SHEET

TO BE FILLED-IN BY SUPPLIER / SUB-VENDOR

NAME OF SUPPLIER / SUB-VENDOR IN FULL		
	REGISTERED OFFICE	FACTORY / WORKS
ADDRESS		
TELEPHONE NO.		
FAX NO.		
EMAIL ID		
PERSON(S) TO BE CONTACTED (NAME & DESIGNATION & MOBILE NO.)		
WEEKLY OFF		

SHIFT WORKING		Type of Company (Pl. Tick)		Type of Industry (Pl. Tick)	
OFFICE	WORKS	Pvt. Ltd	Public Ltd.	MSME	Large Scale
ONE ☐	ONE ☐	Proprietary ☐	Partnership ☐	Govt. ☐	Contractor ☐
TWO ☐	TWO ☐	Public Sector ☐			
THREE ☐	THREE ☐				

SJVN	FORM NO.: F-060-01 PAGE: 2 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

Sr. No.	Items / Services / Process for which Approval is desired for	Rating / Size & Type	Applicable Standards IS/DIN/BS/IEC Etc.

REGISTRATION DETAILS #

PAN / TAN NO.	CENTRAL SALES TAX REG. NO.	STATE SALES TAX / TIN NO.	EXCISE DUTY REGISTRATION NO.

EXCISE CONTROL CODE NO.	SERVICE TAX REG. NO.	CATEGORY OF INDUSTRY	REGSISTRATION NO. & VALIDITY DATE
		Micro ☐ Small ☐ Medium ☐ Large ☐	

	SJVN	FORM NO.: F-060-01 PAGE: 3 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
	FORM	

A.	ORGANISATIONAL SOUNDNESS		
SR. NO.	DESCRIPTION	DETAILS TO BE FURNISHED	
1.	Nature of Business (Strike whichever is not applicable)	Manufacturing Unit / Engineering Consultant / Agents / Distributors / Stockists / Dealers / Traders / Indian Subsidiary / EPC contractor / Channel Partner (Attach authorization certificate of principal) / Erection contractor / Other	
2.#	Year of commencement of Business / Factory Establishment		
3.	Year of Commencement of Manufacture / Services		
4.	Total Area/Covered Area in Sq. m.	**Total Area**	**Covered Area**
5.	Electric Power-Connected Load		
6.#	Electric Power Standby Load & System		
7.	Details of Directors		

Sr. No.	Name	Designation	Qualification	Experience

8.	Details of Employees

Pleases attach copy of Company's Organization Chart (For Unit)

Division Status	Graduate		Diploma	Skilled	Un-Skilled	Remarks
	Technical	Non-Technical				
Production						
Engineering & Quality Control						
Administration & Other Supporting activities.						

	SJVN	FORM NO.: F-060-01 PAGE: 4 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
	FORM	

9.	Brief Details of Product and Manufacturing Capability				
Sr. No.	Item & Material	Description (Type, Size Rating)	Annual Production for Last Three Years		
			I	II	III

10.#	Details of Foreign or Indigenous Collaborator				
Sr. No.	Product	Name & Address of Collaborator	Collaboration		
			Scope	Year	Valid up to

11#	Have your product been type tested by any external agency? If so, give details			
Sr. No.	Product	Test (Size / Type & class	Test Report No.	Next Due date

SJVN	FORM NO.: F-060-01 PAGE: 5 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

12.#	Have you been approved by any Statutory agency / third party agency like LLOYD, ASME, NTPC, PGCIL, EIL, Railways etc. ? If so, indicate details and enclose copies of approval letters				
Sr. No.	Item / Material / Service / Process	Description (Size, Type & Class)	Agency	Date of approval	Next Due date

13.#	Indicate Approval / Certification by National / International Standards / Agencies applicable for the subject product.		
Sr. No.	Product	Codes / Standards	License No. & Date

14.#	Reference List (Experience in Particular Type of Equipment / Service / Process). Please indicate since how many years similar type of item / equipment / service / process provided (please furnish documentary evidence).				
Sr. No.	Item / Material / Service / Process	Type & Capacity / Rating	Customer (End User with Address)	Date of Supply / Service provided	Under Operation since year / Month

#Note: Please furnish the performance feedback certificate for proposed item / equipment / process / service form end user in line with requirement stipulated in Technical Specification.

SJVN	FORM NO.: F-060-01 PAGE: 6 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

15.#	Business Commenced with SAPDC/SJVN in past		
Sr. No.	Year	Name of Department / Project Dealt with	Item Supplied / Services Offered.

16.A#	Machinery, Instrument & other Equipment Specific to Process & Product Facilities / service				
Sr. No.	Description of Machine	Capacity & Nos.	Location Shop	Make	Year of Manufg.

16.B#	Other General Facilities				
Sr. No.	Description of Machine	Capacity & Nos.	Location Shop	Make	Year of Manufg.
i	Material Handling Mobile Crane Fork Lift Over Head Cranes				
ii	Metal Cutting &				

SJVN	FORM NO.: F-060-01 PAGE: 7 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

	Bending				
iii	Casting				
iv	Forging				
v	Fabrication				
vi	Welding				
vii	Machining				
viii	Heat Treatment				
ix	Sheet Metal				
x	Fettling & Cleaning, Sand Blasting, Shot Blasting & Pickling				
xi	Painting				
xii	Metal Coating				
xiii	Protection before packing				
xiv	Packing				
xv	Other				

17.#	If In-House Manufacturing Facilities not available, inform source of manufacturing details along with their facilities and experience			
Sr. No.	Process outsourced	Name of the company	Description of machine / Equipment	Remarks

18. A#	Facilities for In-house Testing & Inspection				
Sr. No.	Description	Capacity & Nos.	Make & Year of Mfg.	Calibration Status	Approval Qualificati on

SJVN	FORM NO.: F-060-01 PAGE: 8 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

18.B#	If In-house testing facilities are not available, indicate source of testing with relevant details.					
Sr. No.	Source of Testing	Description	Capacity & Nos.	Make & Year of Mfg.	Calibration Status	Approval Qualificati on

Note: In case of outsourcing of major testing such as NDT, Electrical & Mechanical testing, no marks will be awarded. However, material composition testing by chemical method from NABL Lab shall not attract negative marking.

18 C #	Details of any Government Laboratory facility available in area	
	Product related testing facility (type / Performance / Routine / Acceptance Test)	

19	Sources of Raw Material and Bought out Items	
Sr. No.	Description of Raw Material / Bought Out Items	Source

20 #	Storage Area Availability	
	Storage for finished goods (Open / Close)	
	Raw Material storage and identification	

SJVN	FORM NO.: F-060-01 PAGE: 9 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

21 #	Do you have in-house Design / R&D departments?	
22 #	Details of pending legal issues on contractual aspects with customers, if any.	
23 #	Please furnish details of Labour problems in the last three years, if any?	

B.	FINANCIAL SOUNDNESS OF ORGANIZATION			
	Financial Information for last Three Years (Please furnish copy of annual report)			
Sr. No.	Parameters	Year 20	Year 20	Year 20
1#	Please furnish annual turnover of the company.			
	Growth in annual turnover w.r.t. previous years (%)			
2#	Please furnish Profit before tax (PBT) of the company.			
	Growth in PBT w.r.t. previous years (%).			
3#	Please indicate the net worth (Net current assets – Net current liabilities) of the company?			
4#	Whether the vendor has been referred to BIFR / NCLT / any other similar Govt. agency.			
5#	Whether the supplier is a potentially sick company.			
6	Please mention current order book position, as on date in terms of Value and time			

C.	QUALITY SYSTEM	
SR. NO.	DESCRIPTION	Sub-vendor response (along with supporting document)
1#	Are you an ISO 9001 company? If yes, please furnish the certificate and what is your quality policy?	
2#	Is the company an ISO 14000 approved?	
3#	Is the company an OHSAS approved?	
4#	Have your company won any Quality award like Rajeev Gandhi National Quality Award, IMC Ramkrishna Bajaj National Quality Award, Golden Peacock National Quality Award etc? If yes provide documentary evidence.	
5#	Have you received appreciation letter from your customer. Please provide evidence.	
6	To whom your Q.C./Q.A. Chief reports to ? (Please furnish your organization structure)	
7#	If you have a written quality control manual/procedure, then please furnish the same.	

SJVN	FORM NO.: F-060-01 PAGE: 10 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

7 (i)#	Incoming Material Control System (Furnish a copy of system and organization)	
7 (ii)#	Process Control: Are written procedure defining stage wise operations and functions on shop floor established and followed? (Furnish copy of work instruction and record of process control parameter)	
7 (iii)#	Manufacturing/Testing Procedure Qualification & Personnel Qualification (Procedure qualification specification & Record of personnel qualification (PQR) to be submitted).	
7 (IV)#	Are written Quality Control Instruction sheets prepared & properly used? (Please furnish evidence)	
7 (V)#	Are records generated during inspection maintained & available for review? (Please furnish evidence)	
7 (VI)#	Are quality control checks / procedure adequate to maintain desired quality level right from the incoming stage to final stage? Please furnish copy of such control checks / procedure.	
8.#	**Documentation Control**	
8 (i)	Does a system for clear and precise stipulation of responsibilities for documentation issue & change control exists?	
8 (ii)	Are changes made in writing?	
9#	**Control of Inspection, measuring and testing equipment**	
9 (i)	Are necessary gauges, testing and measuring equipment's, available and used?	
9 (ii)	Are testing and measuring equipment properly maintained?	
9 (iii)	Is recorded control on calibration of equipment available?	
10#	System of Identification & Traceability of materials, tools, jigs, fixtures & processed components, etc. (Copy of procedure to be submitted).	
11#	System of Storage / Preservation / Painting and Packing (copy of Procedure to be submitted)	
12#	Do you have written procedure for disposing off the non-conformities? If yes, please furnish the copy of the same also furnish three copies of NCR & CAPA.	
13#	Safety measures (Submit copy of safety system & record of accidents for last two years)	
14#	What type of Sampling Inspection Plan is used in your factory/company? Please furnish details.	
15	How good are you in keeping your dispatch commitments? Please give details of last ten deliveries stating details as below (Provide documentary evidence) Within delivery period:	

	SJVN FORM	FORM NO.: F-060-01 PAGE: 11 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016

	Delayed but accepted by user: Delayed but accepted with penalty:	
16#	Have you ever been de-listed or put in under temporary suspension by any customer / contractor.	
D.	**AFTER SALES SERVICE**	
SR. NO.	DESCRIPTION	Sub-vendor response (along with supporting document)
1#	For overcoming product deficiencies what are the analytical methods used at Customer's premises?	
2#	What is the strength of your "after-sales service" team?	
3#	What is the response time after receiving complaints from the customers? Provide evidence.	
4#	Customer complaints handling system (Submit list of customer complaints & status for the last three years) Please furnish complete list of complaints attended to during last one year.	
5#	How do you keep your "after-sales service" team updated?	
6#	Provide certificate from 02 customers (end user) for satisfactory after sails services.	

Declaration by Director/ Partner/ Proprietor

I declare that the information furnished above and attached documents are correct to the best of my knowledge, I undertake to inform you at the earliest any change(s) in the details mentioned above.

Signature and Date

Name & Designation

	SJVN FORM	FORM NO.: F-060-01 PAGE: 12 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016

TO BE FILLED BY MAIN CONTRACTOR FOR SUB-VENDOR (MC)

Sr. No.	Parameters	Supplier response (along with supporting document)
1	Name and address of sub-vendor:	
2 (a)	Type of equipment / item / process / service for which approval is sought:	
2 (b)	Details of equipment / item / process / service for which approval is sought (i.e. Rating, capacity, type, size, weight, etc.):	
3	Experience of main contractor with sub-vendor:	
(a)#	Since how many years sub-vendor is registered with you for proposed type of equipment / item / process / services (furnish documentary evidence):	
4#	Whether sub-vendor is meeting the qualification criteria indicated in the technical specification (furnish documentary evidence).	
5#	Sub-vendor rating as per contractor's internal procedure in the scale 0-10 or 0-100% (furnish documentary evidence).	
6#	Any dispute of main contractor with vendor during execution of last 05 contracts.	
7#	Have you ever de-listed or put in temporary suspension the proposed sub-vendor? If yes, please provide the reason for same.	
8	Please indicate the reason for re-approving / re-listing the sub-vendor.	

I declare that the information furnished by Sub-vendor has been verified and found in order / minor changes which have been marked and initialed on this form itself / observed the following discrepancies.

(Signature & Designation)

SJVN	FORM NO.: F-060-01 PAGE: 13 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

GUIDELINES TO SUPPLIERS FOR FILLING-UP VENDOR/SUPPLIER REGISTRATION FORM

1. All columns are to be filled up properly in the space provided for. Wherever it is not applicable / not available, please mention "Not Applicable" / "Not Available". All pages of the form are to be signed along with seal by the authorized signatory.
2. A separate sheet may be attached if the space provided is insufficient or additional information is to be given, Please put proper identification tag on the separately attached sheet.
3. Any information / clarification required by SAPDC/ Consultant during evaluation must be given expeditiously.
4. Please ensure that all required enclosures are attached with the filled up Vendor Registration Form.
5. Marks shall be awarded on the basis of documentary evidences submitted by Vendor / sub-vendor wherever called in vendor / sub-vendor assessment form.
6. Incomplete or incorrect forms will be rejected.
7. Please fill up the check list given below and send along with the vendor registration forms to SAPDC/Consultant.
8. In case any information found incorrect / false, the vendor shall be rejected / de-listed at any stage.
9. Information with # marks is score able.
10. Accepting or rejecting a vendor is sole discretion of SAPDC.
11. Product catalogue / manual for the proposed item / equipment / process / service, if available, shall be submitted alongwith other documents.

SJVN	FORM NO.: F-060-01 PAGE: 14 of 14 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
FORM	

Furnish following information/Documents:-

Sr. No.	Description	Yes / No	Page No / Annexure
1	Latest audited annual account.		
2	Balance Sheet.		
3	Valid Income Tax Clearance Certificate.		
4	Details of Pending Arbitration cases.		
5	Details of pending disputes with Statutory Authorities.		
6	Organization chart		
7	Copy of Performance certificate (minimum 03)		
8	Copy of minimum three (03) completion certificates of similar work / service.		
9	Letter of approval from ASME / NTPC/ EIL / Railway / Lloyds / Power Grid etc. if any.		
10	ISO: 9001 certificate		
11	Quality Manual		
12	ISO: 14000 certificate		
13	OHSAS, ISO 18000 certificate		
14	Experience list		
15	Type test report & approval certificate		
16	Product Approval certificate from national / international agency.		
17	Quality award certificate		
18	Process and Personnel qualification certificates		
19	Copy of registration / enlistment with reputed / large organizations		
20	Detail of existing clients and details such as address, contact number and mail address.		
21	List of works / projects of similar nature executed with documentary evidences of works executed in last 02 years.		
22	Other documents mentioned elsewhere in vendor / sub-vendor assessment form.		

(Signature & Designation)

	SJVN	FORM NO.: F-060-02 PAGE: 1 of 1 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
	FORM	

PROJECT NAME (MW)	MANUFACTURING / FIELD QUALITY ASSURANCE PLAN				CONTRACTOR NAME, ADDRESS & LOGO
ITEM DESCRIPTION	SUB-ITEM	QAP NO.	REV. NO	ISSUE DATE	SUB-CONTRACTOR NAME, ADDRESS & LOGO

SR. NO.	COMPONENT & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	10			11

LEGENDS

M	MANUFACTURER	C	CONTRACTOR	S	SAPDC LTD.
P	PERFORM	V	VERIFICATION OF RECORDS	W	WITNESS / CHP
IR	INSPECTION REPORT	DRG	DRAWING	CHP	CUSTOMER HOLD POINT
MA	MAJOR	MN	MINOR	CR	CRITICAL
ME	MEASUREMENT	NDT	NON DESTRUCTIVE TESTING	HT	HEAT TREATMENT
TR1	CERTIFICATE OF COMPLIANCE TO TS/STANDARD REQUIREMENT WITHOUT ANY CHECK LIST OF TESTS CARRIED OUT.	TR2	CERTIFICATE OF COMPLIANCE TO TS/STANDARD REQUIREMENT WITH CHECK LIST OF TESTS CARRIED OUT.	TR3	TEST REPORT/TEST CERTIFICATE WITH TEST RESULTS BASED ON SPECIFIC INSPECTION & TESTING AT MANUFACTURER FACILITY/NABL APPROVED LAB.

NOTE: QAP SHALL BE READ IN CONJUNCTION WITH QUALITY ASSURANCE REQUIREMENT GIVEN AS PART OF TECHNICAL SPECIFICATION.

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

Prepared By:	Reviewed By:	Approved By: Process Owner

SJVN	FORM NO.: F- 060-04 PAGE: 1of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 1 of 5

PART-A (Proposal of Disposition of Non Conformity)

Please read instructions carefully before filling up the form and attach separate sheet wherever required.

Contract No.	CATEGORY OF NON CONFORMITY (Please refer instruction no.1&Tick appropriate)
Package Unit No.	
Supplier/ Contractor	MAJOR ☐
Sub-Vendor	
Place of Manufacture	MINOR ☐

DETAILS

ITEM DESCRIPTION: _____ IDENTIFICATION NO._____

RANGE/SIZE/TYPE: _____ QUALITY PLAN NO.: _____
& CLAUSE NO._____

STAGE OF NON-CONFORMITY ☐

DESIGN (A) /RAW MATERIAL (B) /ASSEMBLY (C) / IN PROCESS (D)-Specify_____/
TESTING (E)/ STORAGE (F) /HANDLING & TRANSPORTATION (G) /ERECTION &
COMMISSIONING (H) /ANY OTHER (I) (SPECIFY) _____

NON CONFORMITY-DESCRIPTION WITH CAUSE (Attach Relevant Drawings/ Details):

PROPOSED DISPOSITION WITH JUSTIFICATION(For Correction): **Disposition Code** ☐
(Note: Attach Details including design calculation)

SJVN	FORM NO.: F- 060-04 PAGE: 2of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 2 of 5

STEPS TO PREVENT RECURRANCE (For Corrective Action):

ENCLOSURE SUBMITTED BY CONTRACTOR:-
☐ DRAWINGS/ DETAILS ☐ INSPECTION REPORT ☐ ROOT CAUSE ANALYSIS
☐ PROCEDURE OF DISPOSAL OF NCR ☐ ANY OTHER (Please specify)_____

DATE NAME & DESIGN SIG.OF CONTRACTOR SEAL

FINAL DISPOSITIONING BY SAPDC **Disposition Code** ☐

INCHARGE of RIO or FQA (In case of Minor)
SAPDC (In case of Major)

DATE NAME & DESIG. SIGNATURE

SJVN	FORM NO.: F- 060-04 PAGE: 3of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 3 of 5

FOR SAPDC INTERNAL USE ONLY

RECOMMENDATION of INCHARGE of RIO or FQA (In case of Major)/ **CONCERNED SAPDC 's INSPECTION/ SITE ENGINEER** (In case of Minor) — **Disposition Code** [ ]

DATE NAME & DESIG. SIGNATURE

RECOMMENDATION OF SAPDC CONCERNED ENGINEER — **Disposition Code** [ ]

DATE NAME & DESIG. SIGNATURE

GROUP HEAD

DATE NAME & DESIG. SIGNATURE

RECOMMENDATION OF SAPDC (FOR MAJOR CATEGORY)
(Comments of Engineering / Others deptt as applicable to be considered)

DATE NAME & DESIG. SIGNATURE

SJVN	FORM NO.: F- 060-04 PAGE: 4of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 4 of 5

PART B (Verification of Corrections of Non- Conformity)
(Filled after Completion of corrections of Non-Conformity)

ACTION TAKEN BY SUPPLIER/ CONTRACTOR (Attach Report of verification)

DATE NAME & DESIGN SIG.OF SUPPLIER/ CONTRACTOR SEAL

VERIFICATION BY SAPDC'S SITE ENGINEER/ INSPECTION ENGINEER

DATE NAME & DESIG. SIGNATURE

IN-CHARGE of RIO/ FQA

DATE NAME & DESIG. SIGNATURE

COMMENTS OF SAPDC ENGINEER

DATE NAME & DESIG. SIGNATURE

GROUP HEAD

DATE NAME & DESIG. SIGNATURE

HOD

DATE NAME & DESIG. SIGNATURE

SJVN	FORM NO.: F- 060-04 PAGE: 5of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY
	NC NO.
	Date:
	PAGE 5 of 5

INSTRUCTIONS

1. 'MAJOR' NONCONFORMITY IS DEFINED AS DEPARTURE FROM SPECIFICATION WHICH AFFECTS PERFORMANCE RELIABILITY. SAFETY INTERCHANGEABLITY. ERECTION, COMMISSIONING OR WORKING LIFE ALL OTHER NON-CONFORMITIES SHALL BE TREATED AS CATEGORY 'MINOR'.
2. ACCEPTANCE OF DISPOSITIONED NO N-CONFORMANCE IS WITHOUT PREJUDICE TO SAPDC RIGHT TO CLAIM COMMERCIAL REBATE AND DOES NOT ABSOLVE CONTRACTUAL OBLIGATIONS.
3. OBTAINING APPROVAL OF STATUTORY AUTHORITY IF ANY W.R.T. ABOVE NON CONFORMANCE IS THE RESPONSIBILITY OF SUPPLIER/ CONTRACTOR.
4. DISPOSITIONING OF THIS NON-CONFORMANCE IS FOR THIS SPECIFIC CASE ONLY AND NOT TO BE REGARDED AS PRECEDENCE.
5. **DISPOSITION CODE** THE NON-CONFORMANCE SHALL BE DISPOSITIONED AS UNDER BY SAPDC AND SUPPLIER. (GIVE CODE AT APPROPRIATE BOXES):-
   (01) NC-REJECTED **(02)** NC- CONDITIONALLY ACCEPTED (SPECIFY CONDITION) **(03)** NC-ACCEPTED AS-IT-IS **(04)** NC-ACCEPTED WITH REPAIR.
6. **NC NUMBER** - THIS NO. SHALL BE ALLOTTED BY SAPDC AND SHALL HAVE SAPDC,PROJECT NAME, PACKAGE, FOLLOWED BY RUNNING SERIAL NO. & ENTER TO NC REPORT BY RIO / FQA / CQAI.

RESPONSIBILITIES OF CONTRACTOR

1. ASCERTAIN EXACT NATURE OF NON-CONFORMANCE AND ALONGWITH SUPPORTING DRAWING OF ITEMS/ EQUIPMENT ETC WITH WHICH NON-CONFORMANCE EXISTS.
2. IDENTIFY THE CAUSE OF NON CONFORMITY.
3. DECIDE ON CODE OF DISPOSING.
4. FINALISE THE CAUSE OF NON-CONFORMITYAND PROPOSE CORRECTIVE ACTION.
5. ENSURE AND CERTIFY THAT THE PRODUCT QUALITY PERFORMANCE. RELIABILITY AND WORKING LIFE IS NOT AFFECTED FOR MINOR NON-CONFORMITIES AND QUANTIFY THE EXTENT TO WHICH IT IS AFFECTED IN THE CASE OF CATEGORY 'MAJOR' NON-CONFORMITIES.
6. IMPLEMENT AGREED CORRECTIVE ACTION IN A TIME BOUND PROGRAMME AND PROVIDE FEEDBACK AS PER PART-B OF THE FORMAT

RESPONSIBILITIES OF RIO/ FQA

1. IDENTIFY THE PRODUCT APPROPRIATELY.
2. ANALYSE THE CAUSE OF NON-CONFORMITYAND PROPOSE RECOMMENDATION

SJVN	FORM NO.: F-060-06 PAGE: 1 of 1 ISSUE: 2.0 REV. 00 DATE: 30/06/2016
FORM	

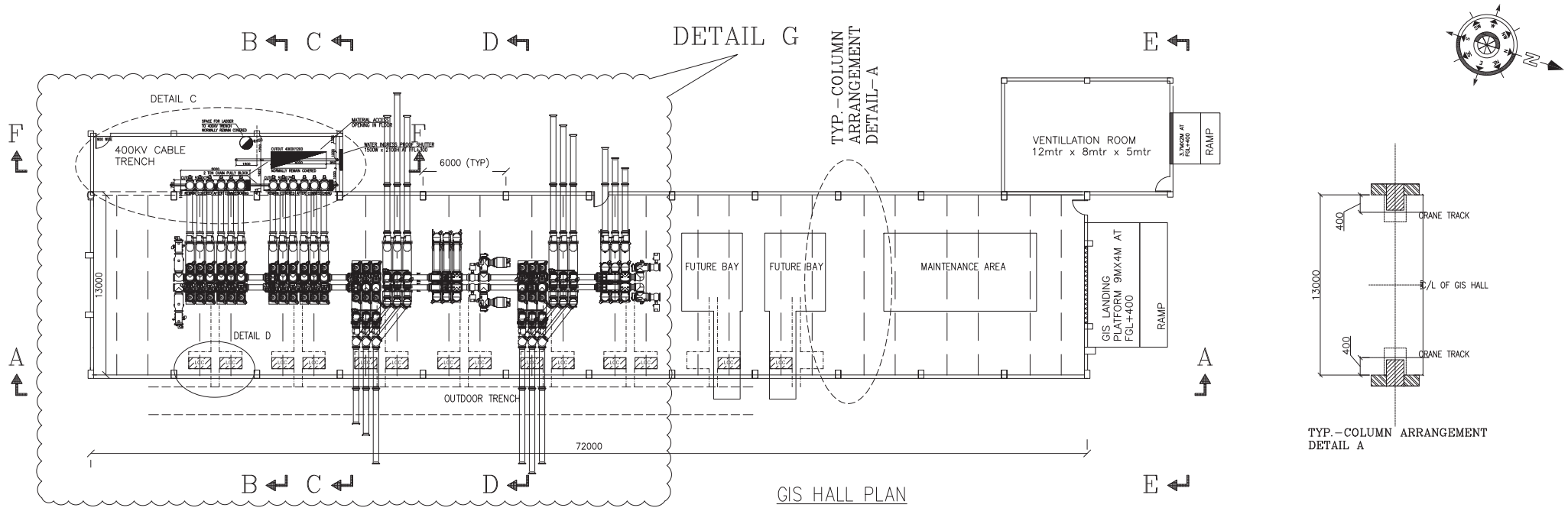
INSPECTION CALL REQUEST

Inspection Call No.			Date:			
Project:			Contract No. :			
Contractor/Supplier's Name & Address:			Sub-vendor/Sub-Supplier's Name & Address:			
Contact Person:			Contact Person:			
Telephone/Mobile No.:			Telephone/Mobile No.:			
Fax No.			Fax No.			
email ID:			email ID:			
Details of Equipment with Unit No.:						
Sr. No.	Equipment/Item Description and Sr. No.	Unit No.	BBU Ref.	QAP No. & Rev. No.	Relevant QAP Clause No.	Approved Drawing No. & Rev. No.
Status of Type Tests	Approved / Not Approved / Not Applicable		Place of Inspection:			
Proposed date of Inspection:			Anticipated Working Days Required			
Status of internal inspection by Vendor/sub-vendor			Completed ☐	In-progress ☐	Yet to be done ☐	
Tentative date of completion of internal inspection in case inspection is in-progress/yet to be done:						
Note: Readiness status is to be submitted separately after completion of internal inspection by Manufacturer.						

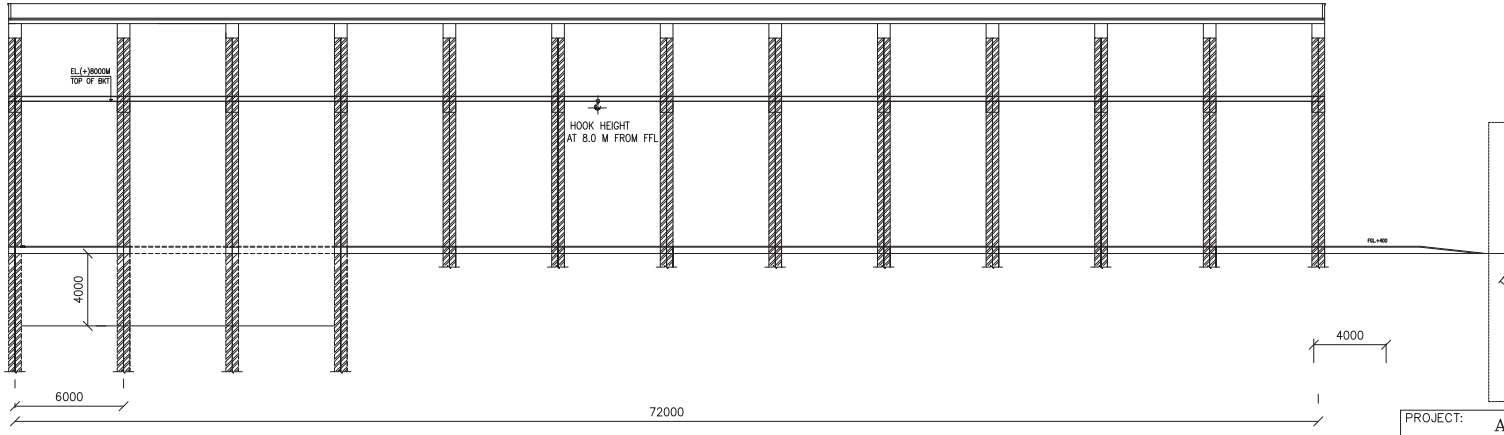
Date:
Place:

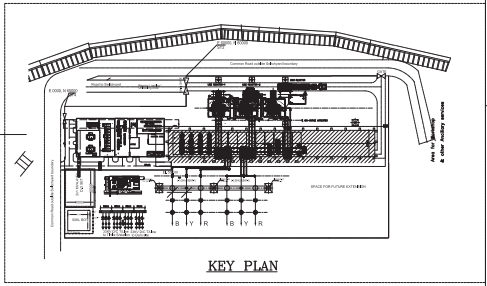
Signature
Name
Designation
Department
Company

DRG. NO. TB-3-405-316-020



TYP.–COLUMN ARRANGEMENT
DETAIL A





KEY PLAN

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHD/APPD			CHD/APPD	02	02.09.2021	CHD/APPD	01	05.07.2021	CHD/APPD
ZONE			ZONE			ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM DTD–20.08.2021		ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM dtd–22.02.2021 & email dtd–22.03.2021	

PROJECT: ARUN–3 HYDRO ELECTRIC PROJECT (NEPAL)
(4 x 225 MW)

CUSTOMER: SJVN ARUN–3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LTD.
(A JOINT VENTURE OF GOVT OF INDIA AND GOVT OF HP)

BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION BUSINESS GROUP
NOIDA

	NAME	SIGN.	DATE
DRN.	PK		27/01/2021
CHD.	VYOM/JK		27/01/2021
APPD.	SKS		27/01/2021

DEPT. TBG | CODE | SCALE NTS | CARD CODE

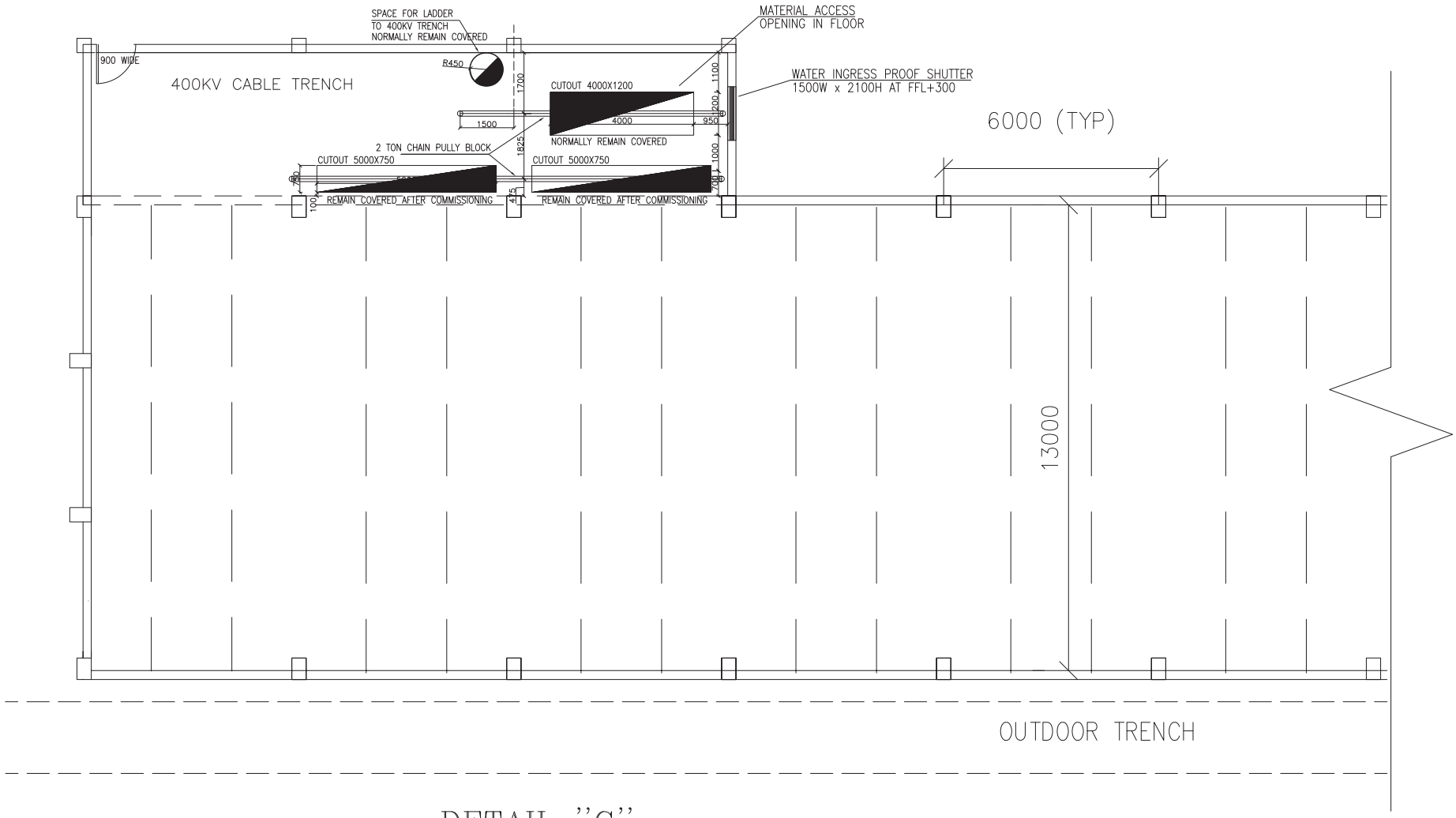
TITLE: LAYOUT OF GIS BUILDING OF 4x225MW ARUN–3 HEP

DRG.NO. TB–3–405–316–020 | REV. 03

SHT. No 01 | NO. OF SHT. 05

SIZE–A3

DRG. NO. TB-3-405-316-020



DETAIL ''G''
GIS HALL PLAN

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHD/APPD			CHD/APPD	02	02.09.2021	CHD/APPD	01	05.07.2021	CHD/APPD
ZONE			ZONE			ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM DTD-20.08.2021		ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM dtd-22.02.2021 & email dtd-22.03.2021	

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT (NEPAL)
(4 x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LTD.
(A JOINT VENTURE OF GOVT OF INDIA AND GOVT OF HP)

BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION BUSINESS GROUP
NOIDA

	NAME	SIGN.	DATE
DRN.	PK		27/01/2021
CHD.	VYOM/JK		27/01/2021
APPD.	SKS		27/01/2021

DEPT. TBG CODE | SCALE NTS | CARD CODE

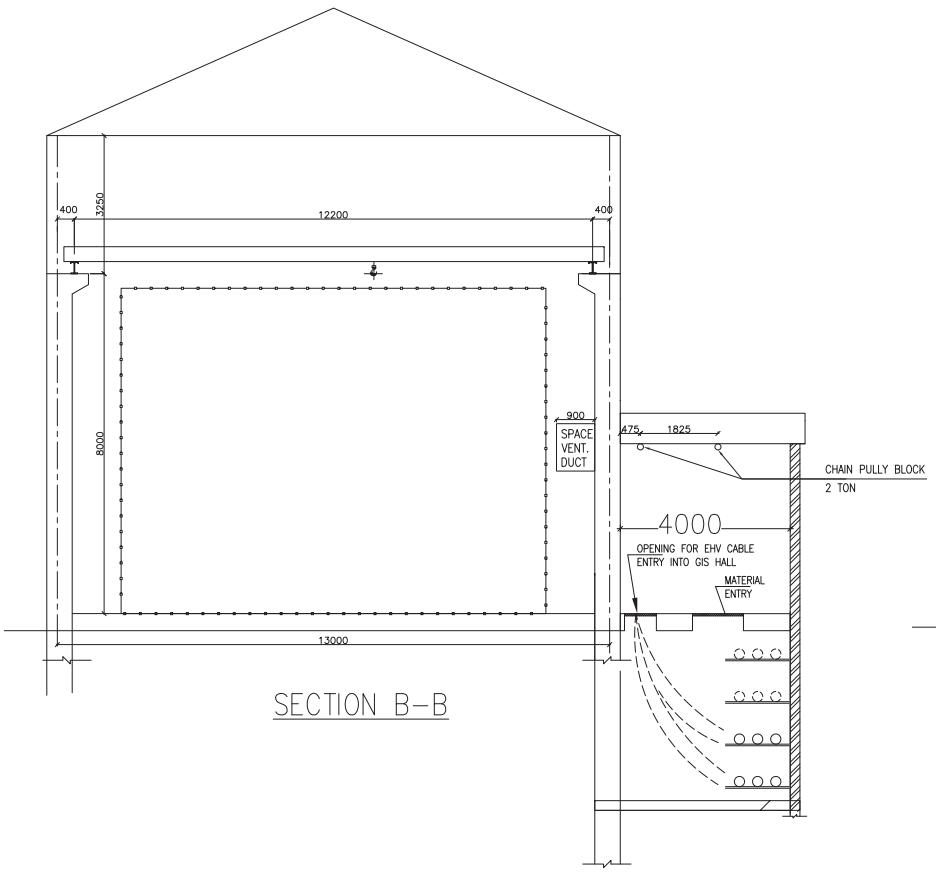
TITLE: LAYOUT OF GIS BUILDING OF 4x225MW ARUN-3 HEP

DRG.NO. TB-3-405-316-020 REV. 03

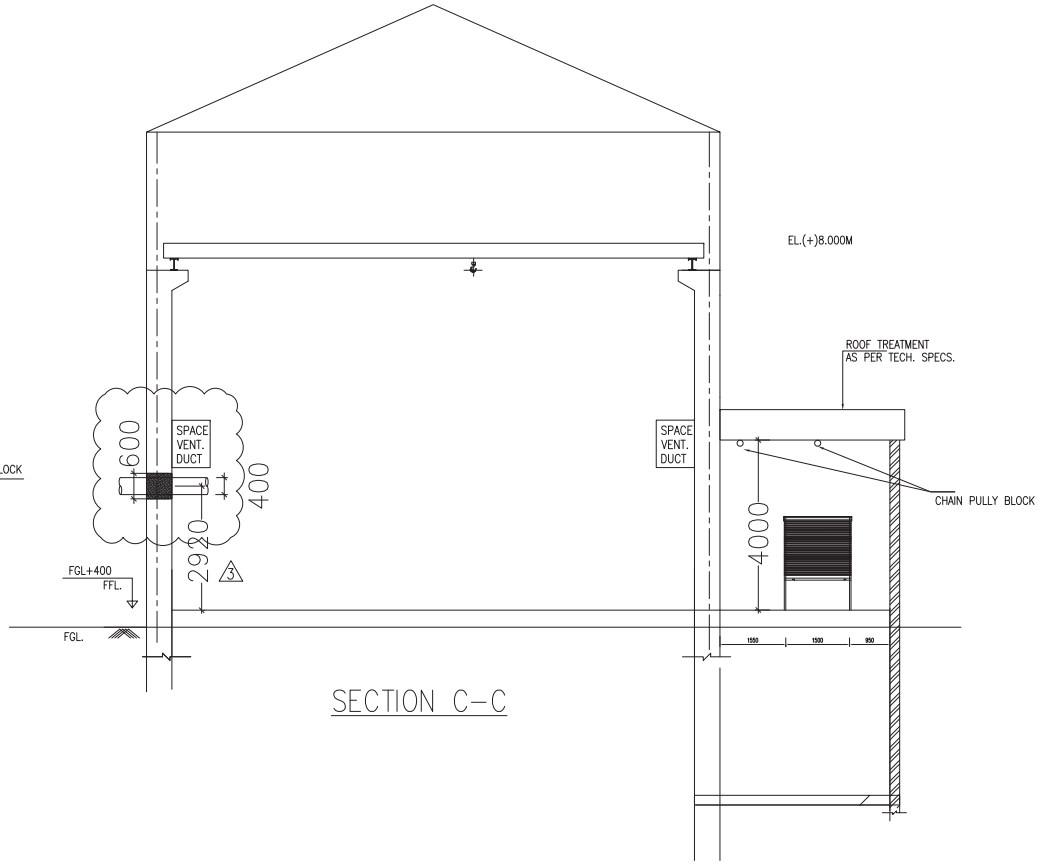
SHT. No 02 NO. OF SHT. 05

SIZE-A3

DRG. NO. TB-3-405-316-020



SECTION B-B



SECTION C-C

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHD/APPD			CHD/APPD	02	02.09.2021	CHD/APPD	01	05.07.2021	CHD/APPD
ZONE			ZONE			ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM DTD-20.08.2021		ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM dtd-22.02.2021 & email dtd-22.03.2021	

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT (NEPAL) (4 x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LTD. (A JOINT VENTURE OF GOVT OF INDIA AND GOVT OF HP)

BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA

	NAME	SIGN.	DATE
DRN.	PK		27/01/2021
CHD.	VYOM/JK		27/01/2021
APPD.	SKS		27/01/2021

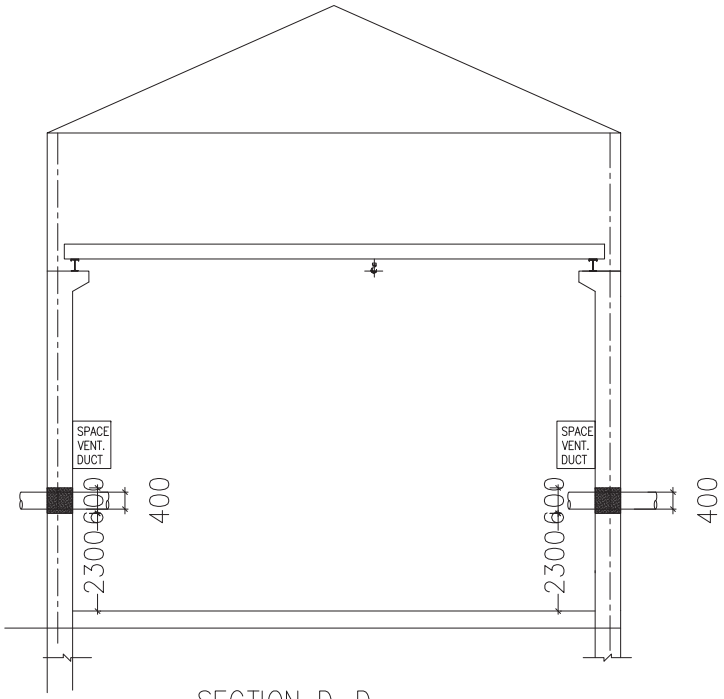
DEPT. TBG | CODE | SCALE NTS | CARD CODE

TITLE: LAYOUT OF GIS BUILDING OF 4x225MW ARUN-3 HEP

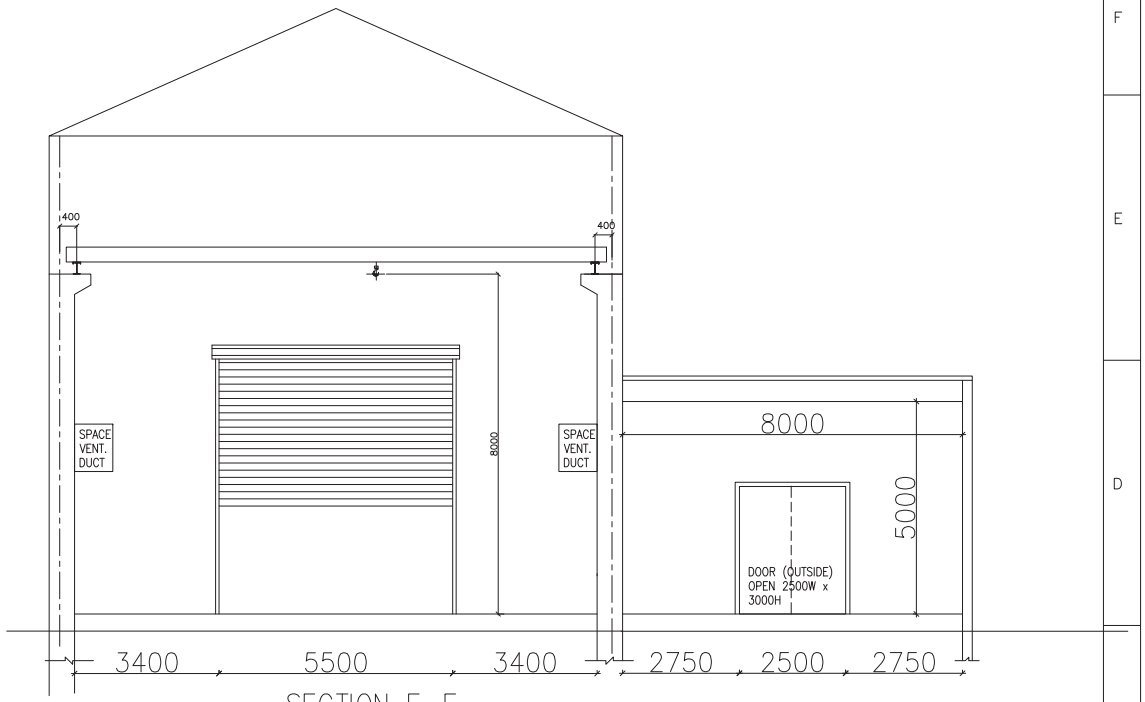
DRG.NO. TB-3-405-316-020 | REV. 03

SHT. No 03 | NO. OF SHT. 05

SIZE-A3



SECTION D-D
LINE + REACTOR BAY



SECTION E-E

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
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ZONE			ZONE			ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM DTD-20.08.2021		ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM dtd-22.02.2021 & email dtd-22.03.2021	

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT (NEPAL) (4 x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LTD. (A JOINT VENTURE OF GOVT OF INDIA AND GOVT OF HP)

BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA

	NAME	SIGN.	DATE
DRN.	PK		27/01/2021
CHD.	VYOM/JK		27/01/2021
APPD.	SKS		27/01/2021

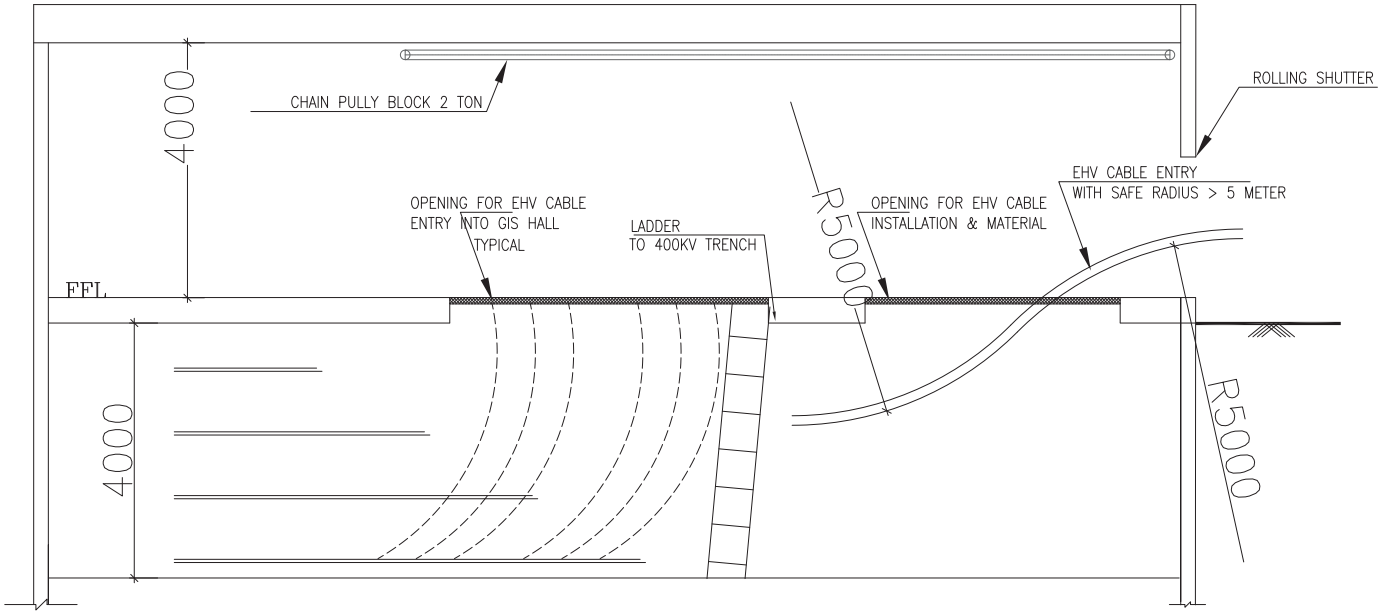
DEPT. TBG | CODE | SCALE NTS | CARD CODE

TITLE: LAYOUT OF GIS BUILDING OF 4x225MW ARUN-3 HEP

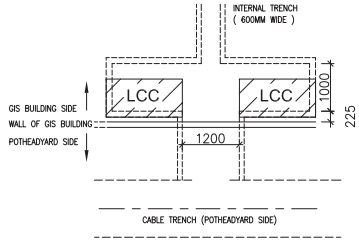
DRG.NO. TB-3-405-316-020 REV. 03

SHT. No 04 NO. OF SHT. 05

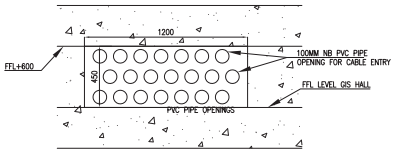
SIZE-A3



SECTION F–F



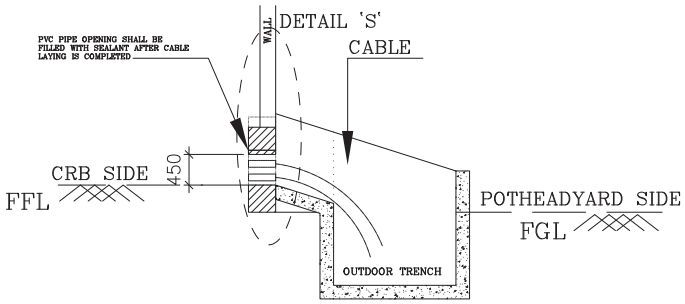
DETAIL D : PLAN OF CABLE TRENCH IN GIS BUILDING



DETAIL "S"

NOTES :–

1. ALL DIMENSION ARE IN MM UNLESS OTHERWISE MENTIONED.
2. HEIGHT OF ROOMS SHOWN IN SECTION IS CLEAR HEIGHT FROM BEAMS BOTTOM TO FFL.
3. CABLE ENTRY FOR ALL PANELS SHALL BE THROUGH BOTTOM.
4. DETAIL OF EHV CABLE TRENCH DRAWING SHALL BE SUBMITTED SEPARATELY.
5. HEIGHT OF GIS BUS DUCT EXIT TO BUILDING MAY CHANGE. WE SHALL SUBMIT THE SAME SHORTLY.
6. THE ROOF IS CONSIDERED TO BE SLOPING TYPE.
7. THE GIS BAYS ARE TO BE ARRANGED IN SUCH A WAY THAT FAULTY CBS CAN BE REMOVED WITHOUT DISTURBING ANY HEALTHY PHASE.
8. STATIC & DYNAMIC LOAD OF CIRCUIT BREAKERS OF GIS, OTHER EM EQUIPMENT WHICH ARE PLACED IN OTHER BUILDING SHALL BE SUBMITTED WITH GIS LAYOUT.
9. CIVIL GUIDE DRAWING OF GIS BUILDING SHALL BE SUBMITTED SEPARATELY.
10. 50X50X6 EDGE PROTECTION ANGLES ARE TO BE PROVIDED ON ALL CABLE TRENCH & FLOOR CUTOUT.



CABLE ENTRY TO GIS BUILDING

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHD/APPD			CHD/APPD	02	02.09.2021	CHD/APPD	01	05.07.2021	CHD/APPD
ZONE			ZONE			ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM DTD–20.08.2021		ZONE	REVISED IN LINE WITH THE CUSTOMER COMMENTS DATED THROUGH MOM dtd–22.02.2021 & email dtd–22.03.2021	

PROJECT: ARUN–3 HYDRO ELECTRIC PROJECT (NEPAL) (4 x 225 MW)

CUSTOMER: SJVN ARUN–3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LTD. (A JOINT VENTURE OF GOVT OF INDIA AND GOVT OF HP)

BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA

	NAME	SIGN.	DATE
DRN.	PK		27/01/2021
CHD.	VYOM/JK		27/01/2021
APPD.	SKS		27/01/2021

DEPT. TBG | CODE | SCALE NTS | CARD CODE

TITLE: LAYOUT OF GIS BUILDING OF 4x225MW ARUN–3 HEP

DRG.NO. TB–3–405–316–020 REV. 03

SHT. No 05 NO. OF SHT. 05

SIZE–A3