

VOLUME-2
PART- I
Section-15
EOT Cranes

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15. ELECTRIC OVERHEAD TRAVELLING (EOT) CRANES

15.1 Intent of Specifications

The intent of these specifications is to define the scope of work under this section which covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, storage at site, erection, pre-commissioning testing, commissioning, performance testing, acceptance testing, training of Purchaser's personnel, handing over to Purchaser of one (1) no. 40 /10 T EOT Crane for power House of Keyi Hydro Electric Project, Arunachal Pradesh as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The crane is required to lift the heaviest equipment in powerhouse (which is assembled generator). In case during the detailed engineering weight of heaviest equipment exceeds the specified capacity, the contractor shall supply the cranes and associated equipment of enhanced capacity without any extra charge. Also no charges shall be payable for any increase in span if necessitated to meet the hook approaches.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to curb/define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

15.2 Scope of Supply

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

15.2.1 40 /10 T EOT crane for powerhouse

- One (1) nos., 40/10 metric tonnes or higher capacity double girder powerhouse electric overhead travelling bridge crane, complete with electric control panels, operator's pendant control, main and auxiliary hoists on a common trolley, brakes, safety devices, platform, ladders, fittings and connections and all necessary accessories.

15.2.2 Miscellaneous components and auxiliary system for Powerhouse Crane

- One (1) set of main runway rails 90 lbs or higher capacity with base plates, anchor bolts, rail clips, lock nut, end stops, limit switches, striker's plates, buffers etc. for the crane.
- One (1) set of bridge rails 90lbs with rail clips, lock nut, end stops, limit switches, striker's plates, buffers etc. mounted on each of the crane girders.
- • One (1) set of long travel feed rail power supply system (DSL) complete with PVC enclosures, conductors, collector trolleys, all fittings and connections etc. for total runaway length of the crane as per layout drawings.

- One (1) lot Lubricating oil, grease and hydraulic brake fluid for first filling of all components with 10% reserve, in non-returnable drums.
- Spare parts.
- Special Tools & Tackles shall be provided along with the crane.

15.2.3 Scope of Services for Powerhouse Crane

- Site storage and handling
- Site installation and commissioning.
- Performance and field acceptance testing as per the relevant clause of this section and submission of report.
- Training of Purchaser's personnel including operation and maintenance staff as defined in in the specification.
- All the technical documentation including preparation and submission of O&M manuals.
- All drawings including schematic drawings
- Cable schedule

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 practices.

15.3 Specific Parameters and Layout Conditions

15.3.1 Powerhouse Crane

The powerhouse EOT crane shall be required for handling the heavy equipment like turbine, assembled generator, transformers, associated apparatus and other equipment in the powerhouse. The crane shall also be used for the installation of above equipment as well as for the routine maintenance after commissioning of the generating units in powerhouse.

The crane shall also be used for unloading all the equipment from trailer to Service Bay for assembling and subsequent erection & commissioning at its place of installation.

The crane design shall be co-ordinated with the capability required for handling of main inlet valve, turbine, generator and transformer design in respect of capacity and location. Terminal clearances and hook approach of powerhouse EOT crane shall be suitable with the location of equipment shown in layout drawing.

15.4 Codes & Standards

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

SI No.	Publication No.	Title
1	IS - 3177 /BS : 466	Code of Practice for Electric overhead travelling cranes and gantry cranes other than steel work crane.
2	IS - 807 / BS : 2573	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists.
3	IS-5749/BS: 3017	Forged Ramshorn hooks.
4	IS-2266/BS: 302	Specifications for steel wire ropes for general engineering purposes.
5	IS - 6938	Code of Practice for design of rope drum and chain hoists for hydraulic gates.
6	IS - 325/BS: 2960	Three phase induction motors.
7	IS-13947 (Part4/sec1)	Contactors and motor starters - Electromechanical contactors & motor starter.
8	IS - 2062	Steel for general structural purposes
9	IS-1030	Carbon steel castings for general engineering purposes
10	IS-1875	Carbon steel billets, bloom, slabs and bars for forgings
11	IS - 210	Grey Iron castings
12	IS - 1363 (Part 1, 2, 3)	Hexagon head bolts, screws & nuts of product grade- C
13	IS-1364(Part 1, 2, 3, 4, 5)	Hexagon head bolts, screws & nuts of product grade A & B
14	IS - 4460 (Part 1, 2, 3)	Gears - spur & helical gears - calculation of load capacity
15	IS - 800	Code of practice for general construction in steel
16	IS - 2762	Wire rope slings and sling legs
17	IS - 3443	Specifications for Crane Rail
18	IS - 13834	Mechanism Classification of Cranes
19	IS - 7098-1	Cross Linked Polyethylene insulated PVC Sheathed electric cables for working voltage up to & including 1100V
20	Other equipment	Applicable ISS or equivalent standards

15.5 Rating and Functional Characteristics

15.5.1 Standards

Unless otherwise stated hereafter, rating, characteristics, design, test and test procedures, etc. concerning the EOT crane shall comply with the provisions and requirements of IS 3177-1999, IS 807-1984, and other Indian and International Standards. Any design feature or details not specified herein

shall be in accordance with the above-mentioned standards, which shall supplement these specifications.

15.5.2 Rating of EOT cranes

Number of Cranes	One (1) Powerhouse crane
Duty or class of Crane	Class M3
Main Hoist	40 metric tonnes
Auxiliary Hoist	10 metric tonnes
Working clearance required for crane movement/ maintenance from the extreme point of crane to the nearest side obstruction on upstream and downstream of powerhouse	>250 mm
Maximum distance between top of crane rail and the highest point of Crane	<3000 mm
Terminal Positions of Crane	
Main hook / auxiliary hook from the centre of the crane rail on upstream side	<1500 mm / 2500 mm
Auxiliary hook/Main hook -from the centre of rail on downstream side	<1000 mm/ 2000 mm
Maximum operating speed (loaded)	
Long (bridge) Travel	10m/min.
Cross (trolley) Travel	8m/min.
Main Hoist lift	1.0 m/min.
Auxiliary Hoist lift	4m /min.
Minimum Incremental movement (not greater than the given values)	
Main Hoist	1.0 mm
Auxiliary Hoist	3.0 mm
Bridge Travel	5.0 mm
Trolley Travel	5.0 mm
Acceleration/deceleration for	
Bridge Travel	0.07 m/sec ²
Trolley Travel	0.07 m/sec ²
Means for micro speed for inching motion	VVVF control

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

15.6 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. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

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

Minimum factor of safety for crane and its equipment shall be as per IS 3177, IS 807.

15.6.1 Safety requirements

In the design of Crane, all safety regulations as applicable with Factory Acts, Indian Electricity rules etc. as prevailing in the country and the site of installation shall be taken into consideration and provided for.

Correct vertical motion functioning shall be guaranteed within the above mentioned ranges of expected frequency and supply voltage variation.

In the event of a loss of electrical supply, load control shall be ensured.

15.7 Design Requirements

15.7.1 General

The EOT crane shall be electrically driven, single trolley, double girder overhead travelling type. The cranes shall operate on runway rails. The bridge of the cranes shall be carried on sufficient number of wheels 4 nos. long travel and 4 number trolley, mounted on trucks, designed to distribute the load equally on the truck beams and wheels and to allow the wheels to adjust themselves to the irregularities of the rail. Full-length platform shall be provided in drive side and two short maintenance platform in idle side to the outside of each bridge girder. Power shall be supplied from the feed rail power supply system mounted at convenient height along the length of powerhouse.

The dimensions of runway length and span are tentative for each crane and shall be finalized at detailed engineering stage only. The Contractor shall supply the materials/equipment as per approved drawings and bill of materials.

The control system shall contain all the necessary controls for the operation of all the movements of bridge, trolley, main hoist and auxiliary hoist.

powerhouse EOT crane shall be provided with pendant controls to perform all operations of the crane.

15.7.2 Allowable stresses

Allowable stress shall be as per the applicable IS: standards.

15.8 Construction

15.8.1 Bridges

The Crane Bridge shall be of box type all welded construction with web plates stiffened by suitable diaphragms. All parts of the crane and runway rails shall be designed to sustain the loads and the combination of loads listed below with due allowance for eccentricity of loading without exceeding the 70% of allowable stresses.

- Dead load: The weight of all effective parts, the bridge structure, the machinery parts and fixed equipment supported by the structure.
- Live loads: The weight of the trolley and lifted load (rated capacity) considered as concentrated moving loads at wheel and located in such a position as to produce the maximum moment and shear.
- Vertical impact load: Impact factor given in standard.
- Braking load: The force produced on sudden application of bridge travel brakes while carrying rated load and travelling at full speed with the power cut off.
- Dynamic load: Each crane shall consist of two bridge girders supported on end trucks. The girder end connections to trucks shall be rigid so as to prevent skew in operation of crane. The cranes shall have substantial connections at top and between the girders to hold the girders and end girder connection in a rigid rectangular shape. The girders shall be designed to safely carry the full rated load without undue vertical or, lateral deflection or vibrations. Bridge shall carry the rails on which a wheeled trolley is to run. The girder shall be designed so that vertical deflection caused by the safe working load and weight of crab in the central position (without taking into consideration the impact factor) shall not exceed 1/750 of the span as per IS 3177, IS:807. The design of the bridge girder shall take into account the transport limitations as mentioned in the section "General Information and Requirements". If a spliced joint is required, it shall be of bolted type.

15.8.2 Bridge travel mechanism

The bridge travel mechanism shall comprise of electric motors for driving at least 25% of the bridge wheels on each rail. The motors shall be located near each end of the bridge and connected to separate gear reduction units. Longitudinal travel of the Crane shall be affected in such a manner that equal speed is ensured at each end trucks without skewing.

The motor shall drive the bridge wheel through a totally enclosed gearbox. Gears shall be herringbone/helical type. The motion shall be free from vibration, rocking etc. under all conditions of operations and the crane structure shall not have tendency to get out of line. All gear reducers and drive mechanisms shall be designed and located to enable easy bridge wheel replacement within the confines of the powerhouse or other space limitations.

15.8.3 Trolley

The trolley shall consist of a welded form of structural steel section adequately braced to withstand vertical, lateral and torsional strains without undue deflection, and properly machined to receive the hoisting drums, wheel axles and motors for hoisting and cross travel. The trolley wheels and winding drums shall have heavy-duty roller bearings. Trolley wheels shall be made of rolled steel or forged steel. Each wheel shall be fitted with two roller bearings each mounted in a capsule housing held in place with two through bolts. Trolley wheels shall be double flanged. Bearing caps shall be provided with fittings for pressure lubrication. Bearing housing shall be so designed as to permit easy removal of shaft. On the bottom of the trolley frame on each side, double end spring buffers shall be provided to engage stops at each end of the bridge. The hoisting arrangement shall be so installed on the trolley, so that the rope reeving arrangement resulting there-from shall ensure lifting of load in almost vertical line with minimum swing or side movements.

15.8.4 Trolley drive mechanism

The trolley drive motors should be mounted on the trolley frame and arranged to drive at least one driving wheel on each side of the trolley frame through gearing and shafting.

15.8.5 End trucks, wheel and axles

The Crane Bridge shall be carried on the end trucks fitted with drive and idle wheels. Trucks shall be fabricated from high-grade structural steel IS: 2062. Heavy gusset plates shall be attached to the bottom of the truck to ensure rigidity and squareness. Each truck shall be fitted with buffers and double flanged rail wheels with roller bearings mounted on rotating axles for easy maintenance. The truck shall be arranged so that wear may be compensated in order to maintain the drive gear in proper condition. The size of journals shall be ample to carry the rated capacity load at specified speed without excessive heating during continuous operation. All trucks shall be designed to permit easy wheel removal.

Trucks shall be equipped with rail sweeps, extending below the top of rail and projecting in front of the truck wheels, to push forward off the track, any object placed across the rail.

Safety lugs shall be provided which shall extend below the top of rail on both sides to prevent the trucks from leaving rails. Wheel assembly shall be arranged such that, replacement of a wheel can be achieved from the side without undue difficulties.

The end trucks shall be designed to contact end stops and the contact faces shall be fitted with resilient bumpers or, spring buffers. The end stops shall be provided and they shall be designed such that they contact the face of the buffer fitted on end truck and not the wheel. The stops shall be attached at each end of runway rails.

The design and construction of track wheels shall be in accordance with IS: 3177. The bridge shall be carried on sufficient number of wheels Total 4 nos. of wheel in long travel. All wheels shall be double flanged with tapered/straight treads, machined or ground to size. The high side of the taper shall be towards the centre of the span or adjacent to the inside bearing of the truck. The wheels shall be made of forged steel (C55Mn75 /55C8) or rolled steel and shall be mounted in such a manner so as to facilitate removal and replacements.

The tread width shall have proper clearance for the railhead and shall be of sufficient size to withstand maximum static and rolling loads as per relevant International or Indian Standards. The tread diameter shall be as per relevant International or Indian Standards and preferably be standardized to size specified in relevant standards. The truck axles shall be made of forged carbon, or alloy steel and shall be accurately turned ground and polished at the wheels. All axles shall be forced fit into the wheel and the driving wheels shall be keyed to the axles in addition to the forced fit.

Truck wheels shall be provided with roller bearings with high-pressure grease lubrication. All bridge truck bearings shall be interchangeable. Wheels bearings and journals shall be easily removable from the truck bodies.

15.8.6 Hoisting machinery

The main hoist and auxiliary hoist (as applicable) shall be mounted on trolley framework. The hoists shall be driven by suitable motors, gears to obtain the required hoisting speed and VVVF drives. Each

hoist shall be provided with two brakes (EHT+DC EM shoe) working on different principles. Equalizers shall be included to assure that the tension in the rope is equalized.

Gradual and very slow accurate control operation for the crane shall be by means of stepless frequency converter control enabling control motion of the hoist within 1 mm.

15.8.6.1 Hoist drum and wire rope

The trolley shall be provided with separate rope winding hoisting drum for main and auxiliary hoists. Each drum shall be designed to take full length of hoisting rope in one layer without layer winding. The end of the wire rope shall be anchored to the drum in such a way that the anchorage is readily accessible. Hoisting drum shall be flanged or guarded and provided with deep-machined grooves in sufficient nos. to leave at least two coils of rope in the groove when the hook is in the lowest position. At least, one groove shall remain unused when the hook is at highest position. Drum shall be designed to withstand compressive stress caused by the wound on rope, the bending stress due to beam action on the drum and torsional stress.

The corrosion resistant wire ropes shall be of proper design and construction for crane service. The wire ropes shall be of extra flexible plough steel or alloy steel. The rope shall be 6/19, 6/36 or 6/37 class conforming to IS: 2266. Factor of safety based on the nominal breaking strength and safe working load of the rope shall be as per IS 3177.

15.8.6.2 Design of hoist drum

Hoist drums shall be of rolled steel/seamless pipe construction, welded construction and shall be duly stress relieved. Lead angle, grooving, diameter and other parameters of hoist drum design shall conform to relevant International or Indian Standards (IS 3177).

15.8.6.3 Lifting tackle and hook

The lifting tackles shall consist of a lower block and hook, necessary sheaves, flexible steel wire rope etc. The lower block shall be a heavy steel housing to support the sheaves and hook. The load block shall be of enclosed design.

The hook and block shall be arranged to lift without twisting and sidewise pull of load. The main hook shall be "Ramshorn" type conforming to International or Indian standards and auxiliary hook shall be of Shank type point hook conforming to International or Indian standards. Hooks shall be swivelled on antifriction thrust bearings and have adequate capacity to handle maximum load. The thrust bearings shall be provided with facilities for lubrication.

The hooks shall be free to rotate 360° when supporting rated load. Hooks shall be fitted with safety latches designed to preclude inadvertent displacement of slings from the hook saddle.

Hooks shall be made of forged annealed alloy or carbon steel. Hooks shall be designed such that the resultant load on the hook passes through the centreline of the shank. The maximum stress in the hook at its rated load shall not exceed 20% of the ultimate strength of the material. Prior to machining, all hooks shall be subjected to ultrasonic test and wet magnetic particle inspection of all surfaces of the forging.

Construction of the Ramshorn shall be as per IS 5749 and IS 15560 for C type hook.

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

15.8.7 Runway rails

The runway rails along with sole plates, fixing clamps etc. for bridge travel, shall be designed and supplied by the Contractor as per relevant Indian and International Standards. The runway rails shall preferably be 90 lbs/yd type or higher section as per IS: 3443. The faces of the rail lengths shall be Flat with 2 to 5mm gap.

The rails of respective crane shall extend to the full length of the powerhouse including the erection bay. The trolley rails shall be of the same quality and material as that of main runway rails. The rails shall also be supported side ways to withstand the starting and stopping of trolley with load. The Contractor shall supply all the materials required for fixing the bridge and trolley rails. Foundation bolts and other hardware required for fixing the sole plates shall also be supplied by the contractor. The foundation bolts and other hardware shall be supplied by the contractor well in advance of taking up the erection of the crane.

15.8.8 Operator's cabin / Pendant Control

The powerhouse EOT crane shall be pendant control complete in all respects in accordance with relevant standards. 4 Nos. flood light shall be provided under the platform / beneath of bridge girder.

15.8.9 Brakes

Two brakes working on different principles shall be provided for all hoists. Hoisting motion shall be fitted with an electro-mechanical DC brake and electro hydraulic thruster brakes.

Double shoe fail safe brakes shall be provided for Hoisting motion. These brakes shall be of EHT and DC Electromagnetic shoe type. Cross travel & Long travel shall be provided with single brake. This brake shall be of DC EM disc type or geared motor as per suitable design. EHT brakes shall be of AC types & the

Electromagnetic brakes shall be of DC type with rectifier equipment. In addition braking through variable frequency drive shall be available.

The braking torque shall be 1.25 times for two brakes use and 1.5 for one brakes use.

15.8.10 Gears

All crane shall be provided with proper gearing, using least number of gears and pinions to accomplish the needed reduction. All gears in power-operated motions shall be machine cut conforming to relevant International/Indian Standard. The gear trains shall be in totally enclosed oil tight gear cases with welded seams. An inspection cover on the top of gear case shall be provided for quick and easy inspection of gears and for adding oil in the case. Adequate breathing and drainage facilities shall be provided on all gear cases. Means for clear and correct indication of the oil level in gear cases shall be provided. All gears not enclosed in gear case shall be properly guarded.

All gears shall be of cast steel/forged steel, shall be designed for the specified crane duty, and shall conform to relevant International or Indian Standards. The gears and pinion for all the motions shall be herringbone or helical type. Gearbox casing shall be cast iron or fabricated from tested quality cast steel or welded steel plates and duly stress relieved. The casing shall be effectively sealed against oil leakage. Gear cases shall be mounted on machined surfaces. Shims shall not be used.

All gears shall be designed to perform under all conditions of loading without undue noise or vibration as per Indian standard. Gears shall be totally enclosed spur or helical type.

Gears shall of EN-8/EN-9 material having hardness 220-250 BHN, while its pinion shall be of EN- 19/EN-24, material having hardness of 250-280 BHN and shall be designed for the specified crane duty. All gear boxes shall be provided with visual oil level indicators. Gear boxes housing shall be made of cast iron.

15.8.11 Bearings

Bearings shall be of the ball or roller type and shall be designed to permit easy removal of the shaft. All bearings shall be provided with proper lubrication or means of lubrication. Bearings shall be designed to exclude dirt, prevent leakage of oil or grease, and to eliminate the need for frequent lubrication. Shaft bearings shall be placed as close as possible to points of loading. Unless otherwise specified herein, bearings on revolving shaft shall be of the divided type so that each shaft may be removed from the crane with its pinions and gears in position. Bearings shall be easily replaceable. Bearing housings shall be of cast iron, cast steel, or welded steel construction. The service life of the bearing shall be considered based on M3 duty crane.

15.8.12 Drip pans and covers

All shafts shall be made of high tensile rolled steel or forged steel. The shaft diameter shall be designed to take into account the provision of key slot and splines. The shaft shall be designed so that its deflection is within 1/3000th of span between bearings.

15.8.13 Guarding

All gears, wheels, pinions and chain drives shall be totally encased unless such parts are so situated in relation to the structure of crane as to be as safe as if complete encasement were provided. Effective

guards shall be provided for revolving shafts and couplings unless every set screw, bolt or key on any revolving shaft is sunk, shrouded or, otherwise effectively guarded. The sheaves of hook blocks fitted with two sheaves or less shall be guarded to prevent the trapping of a band between a sheave and the in-running rope. Guards shall be fastened securely. Each guard shall be capable of supporting without permanent distortion the weight of a 90 kg person unless the guard is located where it is impossible for a person to step on it. If hoisting ropes run near to other parts, guards shall be installed to prevent fouling or chafing.

15.8.14 Sheaves

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

The sheave pins shall be made of annealed carbon or alloy steel. All revolving sheaves shall be equipped with standard replaceable roller bearings with dust seals. The load sheave rpm at full rated speed shall be used to size all sheave bearings. Each sheave shall be lubricated by an individual grease fitting. All revolving sheaves shall be statically balanced. Drums, sheaves, bottom blocks, and hoisting rope shall be designed so that when raising or lowering, no crossover reeving should occur. Idler sheave arrangements shall be designed to minimize any twist in the rope.

The diameter of the sheaves at the bottom of the groove, the lead angle and other parameter of sheave design shall conform to relevant International and Indian Standards (IS 3177).

15.8.15 Couplings

All couplings shall be as per relevant standards and shall be designed to suit the maximum torque that may be developed. Alignment shall be such that solid couplings mate accurately. Flexible couplings shall be initially aligned with the same accuracy as solid couplings. Flexible couplings shall be fitted between motor shaft and gear drive when they are directly coupled. Hoist drums shall preferably be connected to gear box output shaft by means of flexible hoist drum couplings or by any other suitable method to cater for misalignment, frame distortion etc. and also to facilitate easy removal of hoist drum.

15.9 Electrical Apparatus and Control

15.9.1 General

All electrical equipment associated with the crane including motors, push buttons, switches, control panels, starters, control transformers, relays, shall be in accordance with relevant International Standards. A three phase, 4 wire power supply at 415 V, 50 Hz shall be obtained by the Contractor at the runway conductors through suitable L.T. Panel arranged at suitable location in the powerhouse. A two way supply control switch shall be installed in the erection bay which shall be fed A.C supply from two boards. A.C supply to runway conductors shall be fed from this switch. The Contractor shall supply all equipment and devices required for this.

Allowable temperature rise of the equipment shall be as prescribed in the relevant Indian Standards or the corresponding International Standards.

15.9.2 Motors

The crane shall be supplied from power station low-tension switchgear cubicle with 415+/-10% V, 3-phase, 4-wire, 50+/-5% Hz supply. The crane shall be equipped with motors of ample capacity for the duties, speed. Type and routine test on motors shall be as per relevant standard. Motor stopping & starting 150 start/hr, (40% CDF) rating. The protection of motor shall be IP:55.

The motors for Hoist (Main and Auxiliary), CT & LT shall be of TEFC SQ. Cage type. The creep speed shall be achieved in all motions through VVVF drive.

15.9.3 Controllers

The crane shall be pendant controlled. The controllers shall be so located that they can easily be operated by one person and permit unrestricted view of the load. The controllers shall be suitably disposed to permit easy inspection, adjustment and replacement of parts. All electrical equipment shall be suitably enclosed so that live parts will not be exposed to accident contact under normal operating conditions. The pendant shall be complete with push buttons for all controls.

15.9.4 Speed regulation

Speed regulation shall be achieved by utilizing VVVF for all motions. The VVVF drive is a variable voltage and variable frequency drive which changes the voltage as well as frequency thus offers the constant torque from minimum to maximum speed setting. This VVVF drive will also indicate the motor current. The rate of change of voltage and frequency can be adjusted to have smooth operation.

15.9.5 Limit switches

Necessary limit switches shall be provided for all crane hoists to prevent over winding, over traversing and over travelling. At least the following limit switches shall be provided for the crane:

- Hoist driven limit switches for the upper and lower hook position,
- Lever-operated limit switches for both end positions of all travel motions.

15.9.6 Detection devices

- Over-speed detection - Each crane hoist shall be equipped with an over-speed detection device, to check the maximum speed under load. They shall be set at 115% of rated speed.
- Load control device - Each bridge or main crane shall be equipped with a load control device that shall display the hoisted load value.
- Overload detection - Each hoisting device shall be equipped with overload detection device that shall stop motion. In case of overload and after local resetting, uptake shall remain prohibited but other motions shall be allowed. After removal of the cause of overload, normal operation shall resume.

- Unbalance Detection - Each balancing system shall be equipped with an unbalance detection device that shall stop the hoisting motion.
- Detection of circumferential cable stagger on drums - Detection of circumferential cable stagger shall stop the hoisting motion.
- Detection of brake wear - This protection shall set off a sound alarm.
- Detection device for obstacles on the track - The two extremities of the end carriages, shall be equipped with limit switches, which shall stop the relevant motion. The design of this device shall be consistent with stopping distances.

15.9.7 Protective panels

The power supply from main collectors shall be protected by a three pole main line contactor and totally enclosed MCCB with a minimum interrupting capacity of 25 kA at 415 V to switch off power supply to the crane with provision to lock in open position. Electrical interlocks shall be provided to prevent the main circuit breaker from being closed unless all the controllers are in 'OFF' position. The circuit breaker control circuit shall be so arranged that it shall not be possible to close main circuit breaker when the contactor of a particular motion has failed to open although the corresponding controller has been brought to its 'OFF' position. Indicating lamp for 'ON' and 'OFF' position of circuit breaker shall be provided. The following protection shall be provided for all motors:

- Single phase protection,
- Instantaneous over current protection,
- Thermal overload relays,
- Under voltage protection.

The contacts of protective relays shall be so worked that the operation of any relay shall trip the main contractor, thus making it necessary to bring all the controls to OFF position before restarting the motor. The instantaneous relays shall be adjustable between 200 - 300% of motor full load current.

All switches, contactors shall be enclosed in suitable cabinet placed in accessible location.

15.9.8 Long travel current collection system

The main runway conductors shall be GI conductor shrouded bus bar and shall consist of four numbers of collectors supported on suitable insulators and intermediate brackets.

The trolley conductors shall be of PVC/TRS flexible trailing cable type made of copper multi standard conductor of adequate size or drag chain system shall be provided.

15.9.9 Power conductors for the crane trolley

Trolley power conductors shall be of the festooned insulated wire type. The cables shall be suspended on bearings operating on I beams of suitable size just outside on the bridge girder.

Each motor on the trolley shall have separate conductors for the power and in no case shall a power conductor be used as a common conductor for more than one circuit. The power conductors shall be

insulated, jacketed, 90°C conductor temperature extra flexible cables. All conductors, insulators and brackets shall be supplied with crane.

15.9.10 Cable wiring and other conductors

All wiring shall be laid on perforated cable trays or clipped on the crane structure by suitable device. All the cables shall have sufficient current carrying capacity as per relevant Standard specification. Cables used for crane wiring shall comply with relevant Indian and International Standards specifications. Unless otherwise agreed, only copper cables shall be used for power & control wiring.

Cross-wires shall be flexible copper wire PVC insulated. Trailing cables arranged in festoon configuration shall be on the bridge. The cable shall be suspended on the bearings operating on I beams of suitable size just outside bridge girder.

15.9.11 Lighting and convenience outlets

The permanent 230 volts lighting system of the crane shall consist of 4 nos. of 250W of lighting units to illuminate uniformly the area under the crane. The ladders, platforms and walkways shall be equipped with vapour-tight incandescent industrial lighting fixtures with clamp or screw guards. The lighting fixtures shall be such that it must be able to withstand the shock and vibrations of the crane.

Fixture units shall be furnished and mounted for general illumination under the crane. They shall be high-pressure mercury type, as specified in these specifications. Fixtures shall be mounted in a position that shall provide a uniform pattern of light for the length of the crane on the floor beneath it. They shall be mounted so that they produce no major shadows and are readily accessible for safe servicing. Ballasts shall be of the constant wattage, high power factor, and weatherproof 2- winding type suitable for operating on the voltage specified. Fixtures shall be of aluminium shock-resistant construction, specifically designed for use on overhead cranes.

Convenience outlets at each end of the bridge shall be provided.

15.9.12 Alarm gong

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

15.9.13 Earthing

The crane structure, motor frames and metal cases of all electrical equipment including metal conduit or, cable guards shall be effectively connected to earth complying Indian Electricity rules 1956 and IS 3043.

15.9.14 Emergency push button

Emergency push button shall be provided in the bridge for emergency tripping. The push button shall be so arranged as to immediately put off the main supply and apply all the brakes simultaneously irrespective of controller position.

An isolator with indication shall be fitted on crane bridge to facilitate safe crane maintenance. It shall be ensured that it is not possible to by-pass isolating switch from floor to prevent inadvertent operation of the crane during maintenance period.

15.10 Miscellaneous Components

15.10.1 Walkways and ladders

platforms, walkways, hand hold, foot hold etc. as necessary to give safe access to and movement in the bridge drive and trolley drive mechanism, and all other components of the crane needing inspection maintenance, lubrication and repair shall be provided for. Walkways shall be provided on both sides along the entire length of the bridge. All walkways and stair ways shall be of rigid construction, with hand railing and non-skid checker plate treads or grating, toe-boards not less than 0.1 m high. Walkways shall be continuous and permanently secured.

15.10.2 Bumpers

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. The trolley shall have two bumpers on each side placed to meet the trolley stops. The bumpers 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.

15.10.3 Holding clamps

As a safeguard against movement of crane off the rail during an earthquake, suitable provision to contain the movement of crane shall be made. Fabricated bracket shall be provided below the end carriage.

15.10.4 Cradles for load test

Design for the cradle shall be provided. However fabrication of the same shall be done at site by the customer. Dead load shall be arranged by customer for site load test.

15.10.5 Safety devices

Following safety devices shall include but not limited to the following:

- Rail sweeps at extremities of end carriage,
- Safety lugs under end carriage to prevent falling of crane beyond 25mm in the event of breakage of axles,
- Safety guards shall cover pulleys and exposed rotating parts like couplings and shafts,
- A guard between the two bridge girders to prevent contact between wire rope and conductors,
- Hand railing on walkways and staircases,
- Toe-guard and hand railings along other edges of platform,

- Off-position interlock on the controllers so that a motion cannot be started unless the
- controller handle is first brought down to off-position,
- Emergency STOP push button in bridge
- Electrical interlock for reversing contactors,
- Safety interlock to take care of loss of attention of operator
- Limit switches for all motions,
- Overload relays and HRC fuses for protection of motors,
- MCCBs in the erection bay to trip A.C power supply to crane in case of overloading/ short circuit.)

15.11 Painting

Before delivery, all exposed, unfinished metal surfaces shall be cleaned and shop painted. Cleaning and preparation of steel surfaces shall be in accordance with relevant standards and they shall be given at least one prime coat the same day. Paint shall be in accordance with applicable portions of relevant Indian and International standards. The colours of the paint shall be selected at the Purchaser's option. All interior surfaces of the crane those are accessible for maintenance inspections shall also be completely painted.

All other interior surfaces shall be painted with only the one (1) coat of primer. The inside of all gear housings shall be painted with two (2) coats of oil resisting enamel as recommended by the gear-housing manufacturer. A quantity and type of paint equal to 15% of the paint used for the second and third coats shall be provided for field touch-up work. The colour of the paint shall be subject to approval of the Purchaser.

15.12 Quality Control and Assurance

To ensure quality during each stage of work, the Contractor shall establish a system defining quality assurance plan/procedures during various stages of work.

The Contractor shall maintain quality control during manufacturing of equipment as per the approved quality assurance plan. Inspections and tests shall be carried out by the Contractor as per approved quality assurance plan with due regard to stipulations in "clause 1.10 - Inspection and Tests" of "General Technical Specification" at various stages of manufacturing for assuring the full compliance of supply with the requirements of specification.

15.13 Drawings, Documents and Design Calculations

15.13.1 Design memorandum

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

15.13.2 Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "Section 1 - of "General Technical Specification (GTS)". These drawings and documents shall include at least the following:

- General Assembly of the crane,
- General Assembly drawing of crab/ trolley,
- Sub-assembly drawing of wheels, hook blocks and hoist drums, end carriage, trolley, gear assembly etc.
- Wiring and Control diagram of the crane showing detailed rating of each motor, cable sizes etc.
- Schematic diagram of EOT crane
- LT rail fixing arrangement drawing with end stopper.

Any additional document not specified above but required to ascertain suitability of design and provisions of this specification shall also be submitted.

15.13.3 Design calculation

The Contractor shall submit the design calculation as per "General Technical Specification (GTS)" covering at least the following, for approval.

- Calculation for allowable stresses ultimate, factor of safety and other parameters for designing the EOT cranes, girders, load on trucks
- Complete data about various stresses/loads etc. under various conditions including worst,
- Calculations for selection of motor, brake, couplings, runaway rails and cross travel rails etc.,
- Calculation for design of bridge girder, end carriage, cradle and girder joint
- Calculation for design and selection of wire rope, rope drum sheaves and wheel size

The Contractor shall also provide other calculations as required by the Engineer for his approval of the Contractor's design.

15.14 Inspection, Shop Assembly and Match Markings

Shop tests (to be inspected) shall include chemical and physical tests on castings, X-ray tests on welds and general inspection of all important casting. Test certificates for motors, contactors, circuit breakers, hoist ropes, hooks, etc. shall be required to be furnished.

The crane shall be completely assembled and operated and load tested in the shop by the motors and controls. Field connections shall be fitted in the shop and match marked suitably to facilitate field erection. The purchaser or his authorised representatives shall have access to the manufacturer's works at all reasonable times for the purpose of witnessing the manufacture, inspection and testing for all components or complete crane.

Any work found defective or which is not in accordance with the approved drawing, standard or contract may be rejected by the inspector.

All materials can be despatched only after test certificate are approved. The approval of the Test Certificates shall be given only if the corresponding drawings and technical particulars of the equipment have been approved by the purchaser.

15.15 Tests

15.15.1 Test at Manufacturer's Works:

All electrical and mechanical equipment shall be tested in accordance with appropriate International or Indian Standard Specification at the crane maker's or equipment manufacturer's works and test certificates shall be furnished.

The crane shall be tested under load on hoisting and cross traverse motions. Travelling gear may be run light to check shaft and gear alignments. Long travel motion test possible on idle condition.

The Tenderer shall clearly list the test that can be performed at his works.

15.15.2 Tests at Site:

Insulation tests:

After erection of crane but before it is connected to the supply, insulation of electrical equipment shall be tested by suitable instruments and any defects revealed, shall be rectified by the contractor. The supply voltage required for the insulation resistance test shall be DC with voltage not less than twice the rated voltage.

Motions and Approach Distances:

The basic parameters like crane clearance shall be verified and the height of lift shall be measured.

Speeds:

The speed load characteristics of the various motions of the crane as offered by the manufacturer shall be verified by the purchaser at his premises by actual loading such as no load, half load, full load at all notches. Any deviation shall be corrected by the manufacturer.

Tests for operation:

After the supply has commenced and before the complete crane installation is put into commercial service, tests shall be carried out to prove the following:

- Satisfactory operations of each controller, switch, relay and other control devices and in particular the correct operations of all limit switches under the most unfavourable conditions.
- The correctness of all circuits and interlocks and sequence of operation.
- The satisfactory operation of all protective devices.
- The satisfactory operation of each motion of the crane.
- The compliance of the crane with the specified performance requirements and

- The tolerance of specified speed at full load shall be within + 10%.

Deflection Tests:

The test shall be carried out with the 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 the crab/lifting beam in central position (without taking into account the impact factor) shall not exceed the values as per latest edition of IS: 3177 and IS: 807 of the span.

Overload Tests:

After tests but before the crane is put into service, it shall, with overload relays appropriately set, be tested to lift and sustain a minimum test load of 125 percent of the working load when the load is located at the centre of the span.

During the overload test each motion including bridge travel, in turn, shall be manoeuvred in both directions and crane shall sustain the load under full control.

The test loads shall be arranged by the Employer, however the cradle shall be arranged by the Contractor.

15.16 Installation

15.16.1 Installation procedure

The Contractor shall submit six copies of all detailed programs and the procedures to be adopted for erection / installation, testing and commissioning, at least six (6) months before start of erection activities/ installation, for approval of the Purchaser.

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

Installation procedures shall ensure that the crane is erected without initial stresses, forced or improvised fits, and misalignments, nicks of high-strength structural steel components, stress-raising welds and rough burrs. Damaged painted surfaces shall be cleaned and repainted after crane is erected.

15.16.2 Performance testing

After commissioning of crane, the test service period of seven (7) days shall follow. During this test service period, the cranes must perform satisfactorily.

15.16.3 Field acceptance tests

Field acceptance tests in accordance with provision in relevant Indian/International testing standards shall be conducted at site before acceptance of crane by the Purchaser. These shall at least include the following:

- Deflection Test - The deflection test shall be carried out with test load of 125 % of rated load at rest and with the crab in central position. The measurement shall not be taken on the first application of load. 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
- Load tests at 100% and 125% of rated load on each crane
- Verification of crane clearance and lifts,
- Incremental movement of hoists/travels

15.17 Spare Parts

The spare parts shall be as per the following list for supply.

Description	Qty.
Main hoist	
Contactors and springs for master controller	One set
Brake solenoid coils complete	One set
Brake lining complete with rivets etc. for each brake supplied	One set
Limit switches of each type	One sets
Auxiliary hoist	
Contactors and springs for master controller	One set
Brake solenoid coils complete	One set
Brake lining complete with rivets etc.	One set
Limit switches of each type	One sets
Bridge drive	
Contacts for main runway collectors	One Set
Contacts and springs for controller	One Set

Brake solenoid coils complete	One Set
Brake lining complete with rivets etc.	Two Sets
Limit Switches of each type	One Set
Trolley drive	
Contacts and springs for controller	One Set
Brake solenoid coils complete	One Set
Brake lining complete with rivets etc.	One Set
Limit Switches of each type	One Set
Bearings for wheels, gear boxes motors etc. for complete crane	One Set

15.18 Special Tools

The Contractor shall propose the list of recommended special tools (other than those included under “Tools and Instruments” above) including their make and detailed specification as recommended by manufacturer(s) and to be accepted by the Purchaser.

15.19 Guaranteed and Technical Particulars

Guaranteed and Technical Particulars as called for in Vol. VI shall be furnished along with the bid. Bids lacking in this may be considered unresponsive. Particulars subject to guarantee shall be clearly marked

15.20 Completeness of Equipment

All fittings and accessories of the EOT crane that may not have been specifically mentioned in these specifications but are usually necessary for completion of above equipment, shall be deemed to be covered by the specification and shall be indicated and furnished by the contractor without any extra charges to the purchaser.

15.21 Deviations from Specification

While the purchaser does not bind himself to accept any deviation, due consideration will be given to any special devices or equipment put forward by the supplier with a view to increase the efficiency of the equipment and minimise the maintenance cost of the equipment as a whole.

Should the supplier wish to depart from these specifications, he shall submit a complete and limited list of such deviation, together with full particulars of the reasons for the deviation in a separate schedule with special reference to clause and paragraph nos. of this specification. Unless this is done and also the purchaser's concurrence in respect of such deviations is obtained in writing, the equipment offered shall be deemed to comply in every respect with these specifications.