

seated position. The controller handles should be conveniently located within easy reach of the operator.

- 1.11.7. Fully adjustable padded seat, rubber matting, suitable fan and lighting arrangement should be provided inside the driver's cabin. One fire extinguisher for extinguishing any electrical fire should be provided in the operator's cabin, or at a suitable location in the case of pendant control.

1.12. ROPE DRUMS

- 1.12.1. The rope drum shall be designed to withstand the compressive stresses caused by the wound on rope and the bending stress due to beam action of the drum.
- 1.12.2. Seamless Pipes will be an acceptable alternative. The steel used shall be to IS:2062-2011 (latest) The rope drum shall be stress relieved after fabrication. T-joints shall be radiographically checked.
- 1.12.3. The drum shall be designed to take the entire length of the rope in a single layer. Free extra turns as specified in IS:3177:1999 (latest) shall also be provided. The drum shall be flanged at both ends with adequate collar size as per IS to avoid slipping of wire rope outside the drum.
- 1.12.4. Cranes shall be designed with number of rope falls varying with lifting capacity as per details given below:

Up to 10.0 tonnes - 4 falls	Up to 75.0 tonnes - 12 falls
Up to 40.0 tonnes - 8 falls	Above 75.0 tonnes - 16 falls

1.13. WIRE ROPES

- 1.13.1. Hoisting ropes, if of the conventional type, should be of 6x36 construction and made out of the best plough steel having tensile strength of 180 Kg/sq. mm. Ropes should be parallel right hand lay as per IS:2266-2002 (latest). The wire rope shall comply to clause 8.3 of IS:3177-1999 (latest). **Tenderers should offer wire ropes of Usha Martin/Bombay wire rope/Mahadev makes.**

1.14. GEARING

- 1.14.1. The gear units in all motions should be light weight with silent running and made of case- carburizing low carbon alloy steels 20MnCr5/16MnCr5/17Mn1Cr95/EN353/SAE 8620 and should conform to relevant Indian/ International standards. They shall generally be in accordance with AGMA or IS:4460-1995 (latest). All gears and pinions must be made from forged blanks only. All gears should be hardened and profile ground for longer life and silent operation. The minimum surface hardness of pinions shall be between 50 to 60 HRC and shall be 2-3 HRC higher than hardness of gears.
- 1.14.2. Worm wheels and bevel gears must not be used. At all stages only helical gears should be used, except in planetary gearboxes, which can be spur type. Overhung or split gears and pinions should not be used.

1.15. GEAR BOXES

- 1.15.1. General: All gear boxes shall be compact, lightweight completely enclosed and of splash lubricated type. All gear boxes shall be oil tight and sealed with compound or gasket. All gear shafts shall be supported in antifriction bearings mounted in the gear boxes. Gear boxes shall be cast or forged from

low/medium carbon alloy steel or cast iron and suitably heat treated or fabricated. The fabricated gear boxes shall be stress relieved before machining and the method of doing so shall be explained in details in the offer. The internal surfaces of the gear box shall be painted with oil and rust resisting paint. Gear boxes shall be provided with breather vents, easily accessible drain plugs, and a suitable oil level inspection glass or indicator such as a dip stick. Adequate radial clearances between the gear box inner surface and outside diameter of the gears shall be ensured and clearance proposed to be provided shall be indicated in the offer. The facial clearance between the inner surface of the gear box and the face of the nearest gear/pinions shall be at least 10mm.

- 1.15.2. **MH/AH LT and CT Gear boxes:** The motors shall be foot mounted. The foot mounted motors shall have split type gear boxes. These shall be of the conventional split type, designed to split horizontally at the shaft center line and fitted so that the top half can be removed for inspection and repair without disturbing the bottom half.

1.16. DRIVE MOTORS:

- 1.16.1. The wheels of each end carriage should be driven by independent synchronized drive motors mounted near each end carriage.
- 1.16.2. A separate cross traverse motor should be used for cross traverse drive through a suitable gear box.

1.17. BRAKES:

- 1.17.1. The hoisting, LT and CT motions shall be provided with fail safe Electro Hydraulic Thrustor brakes. For creep motion of hoist wherever this is specified as per schedule –I an independent brake must be provided.
- 1.17.2. Any crane working outdoors should be provided with an additional storm brake for anchoring when it is left unattended under stormy conditions. The storm brake together with the service brakes should be capable of holding the crane in position during stormy conditions. Wherever crane is working outdoor, the storm brake should be electro hydraulic thrustor type.
- 1.17.3. The maximum braking torque to arrest long travel and cross traverse motions should not be less than 100% of full load torque for each brake. For hoist motion, two brakes should be used and the braking torque for each brake should not be less than 125% of full load torque. One of the two hoist brakes shall be applied with a time lag of 3 seconds in relation to the first.
- 1.17.4. Double shoe brakes should be used for each drive. Brakes should be mounted on the input pinion shaft of all gear boxes. The brake shoe should be of hinged type. Brake levers should be forged and hinge pins should be provided with steel bushes at the bearing points.
- 1.17.5. Brake drums should be of forged or cast steel and should be completely machined. Brake drum diameter should be selected from preferred number series. Width of brake drum should be about 10 mm more than the width of brake shoe on each side. The brake lining should be environmentally sound.
- 1.17.6. The cabin operated crane shall be provided with an additional foot operated brake for long travel wheels.

1.18. COUPLINGS

- 1.18.1. Motor shafts for MH/AH shall be connected to gear box input extension shaft through flexible gear coupling of low GD2 value. For driving the hoist drum gear type flexible coupling shall be used between the rope drum and hoist gear box, where the hub should not be integral with the output shaft, so as to avoid replacement of the whole shaft whenever there is wear and tear in the coupling.
- 1.18.2. All couplings shall be of medium carbon steel and shall be designed to suit the maximum torque that can be developed. Hardness of geared portion in the gear coupling shall be more than 250 BHN. Bolted connections shall be easily accessible for inspection and tightening.

1.19. ROPE SHEAVES

- 1.19.1. All sheaves should be of cast/forged steel or Blackheart malleable iron castings. They should be identical, with the exception of the equaliser sheave. The equaliser sheave should be mounted above the trolley floor and should be easily accessible and removable from the trolley floor level. The equaliser sheave should be arranged to turn and swivel in order to maintain rope alignment under all circumstances. Sheave grooves should be smooth finished for getting increased rope life. The supplier should further ensure that wire ropes are parallel with each other.
- 1.19.2. A resilient low friction rope guide fixed around the grooves of the designed drum as an expanding ring to provide positive guidance to the rope may be provided to ensure correct rope lay.

1.20. BEARINGS

- 1.20.1. Ball and roller anti-friction bearings shall be of reputed make. The acceptable makes will be NBC, SKF, FAG, NORMA, NRB, NTN and KOYO. In view of widespread use of spurious and reconditioned bearings, tenderers should explain in the offer how it is proposed to ensure that only new and genuine bearings of acceptable make are procured and fitted. Preferably, tenderers should confirm that they will submit, to the inspection agency, invoices from OEMs' or their authorized representative as proof of the use of genuine material.
- 1.20.2. For long and cross traverse wheels, spherical roller bearings shall be used. Bush bearings should not be used at any location.
- 1.20.3. Rated life of ball and roller bearings should not be less than the total life in working hours given in the IS Specification for a particular class of duty. Life of bearings should be calculated in accordance with manufacturer's recommendations.
- 1.20.4. Independent bearing housings on long shafts be split on the shaft center line to permit easy removal of the shaft. The bottom surface of all bearing pedestals should be machined, and should bear upon a machined surface.

1.21. LIFTING HOOK

- 1.21.1. Standard plain shank type trapezoidal section hooks should be used unless otherwise specified. These hooks should conform to the relevant Indian Standard Specifications IS:15560 (latest), while the Ramshorn Hook (wherever

specified) shall conform to the relevant Indian Standard Specification IS:5749 (latest).

- 1.21.2. Hooks should be mounted on grease lubricated anti-friction thrust bearings and a protective skirt should be fitted to prevent rotation of the hook. Proof load test as per Indian Standard Specification shall be conducted, either in-house or from a recognised test house. The certificate of proof load test shall be furnished. The bottom block should have protective edging around the wire rope openings.

1.22. BUFFERS

- 1.22.1. Spring loaded or other suitable buffers should be fitted on the four corners of the crane also at the four ends of the bridge girders. Buffers should be rigidly bolted in place, preferably along the center line of the crane rail or trolley rail as the case may be. All buffers should have sufficient energy absorbing capacity to stop the bridge or trolley in either direction when traveling at a speed of at least 50% of the rated speed at full load. Bridge buffers should have a contact surface of not less than 125mm diameter.

1.23. LUBRICATION

- 1.23.1. Grease nipples one for each of the end carriage and one for the trolley platform, should be provided for all grease lubricated bearings, parts of the hoist and wheels for cross traverse and long travel. The grease battery nipples should be located to facilitate regular greasing by the operator with standard equipment.
- 1.23.2. Bottom blocks and pedestal bearings should have independent greasing points. All lubricating nipples should be protected from damage, and be accessible throughout.
- 1.23.3. A lubricating chart should be provided in the manual, indicating all lubrication points, the type of lubricants required and the recommended frequency of lubrication. These details should be repeated, and amplified if necessary, in the Maintenance Manual, which is to be supplied as per requirement indicated elsewhere in the specification.

1.24. DIMENSIONAL TOLERANCES

- 1.24.1. The contractor should ensure that the crane manufactured and erected to take the tolerances specified below:
 - i) Variation in Span $\pm 6\text{mm}$
 - ii) Diagonal on wheels $\pm 5\text{mm}$
 - iii) Long travel wheel alignment $\pm 1\text{mm}$
 - iv) Tilt of wheels or Balance Axle $\pm 1\text{mm}/1000\text{mm}$ (Horizontal & Vertical)
 - v) Trolley wheel gauge $\pm 3\text{mm}$
 - vi) Trolley track gauge $\pm 3\text{mm}$
 - vii) Difference in height between trolley rails [H] for different trolley track gauges shall be within the following limits

'S' (mm)	'H' (mm)
Upto 2500	4

2500 to 4500	6
Above 4500	8

1. GENERAL ELECTRICAL SPECIFICATIONS

1.1. SCOPE OF SUPPLY

1.1.1. The scope of supply relating to electrical portion shall cover the following components

- 1.1.1.1. Down shop leads (wherever required see clause 11 of Schedule – I of technical specification)
- 1.1.1.2. Main current Collection
- 1.1.1.3. Power disconnecting switch on the crane bridge walk way, to be provided, immediately after the main current collection gears.
- 1.1.1.4. Motors
- 1.1.1.5. Protective Switch gears
- 1.1.1.6. Motor control panels.
- 1.1.1.7. Resistors (For slipping motors only)
- 1.1.1.8. Brakes
- 1.1.1.9. Limit Switches
- 1.1.1.10. Socket outlets
- 1.1.1.11. Power and control cables
- 1.1.1.12. Lighting distribution panels.
- 1.1.1.13. Lighting fixtures and lamps
- 1.1.1.14. Cross traverse flexible trailing unarmored cables mounted on roller clamps travelling over bottom flange of R.S. Joist provided for the purpose. Alternatively, drag link cable system is also acceptable.
- 1.1.1.15. Indicating lamps
- 1.1.1.16. Push Buttons
- 1.1.1.17. Two step jockey switches or push button (ref clause 2.8.2.2) **(DG VVVF Drive Crane)**
- 1.1.1.18. Earth wire on crane portion.
- 1.1.1.19. Dead Man's Handle **(DG)**
- 1.1.1.20. Alarms

1.2. STANDARDS

1.2.1. All equipment and material shall comply with appropriate Indian standards (latest). The equipment shall also comply with latest Indian Electricity Rules, as regards safety requirement and other essential provisions of the act applicable to the installation and operation of EOT cranes. All latest standards indicated in Annexure-G of IS:3177-1999 (latest) shall be applicable in general.

- 1.2.2. The equipment shall be designed and selected to facilitate inspection, cleaning replacement and repair and for use where continuity of operation and safety are important considerations.

1.3. ATMOSPHERIC CONDITIONS

- 1.3.1. The ambient temperature at the site at which the crane will be installed may vary from -5°C to $+50^{\circ}\text{C}$ over the year. The relative humidity may be as high as 100%. The atmosphere is expected to be dusty. The crane offered shall be suitably tropicalized to work under these ambient conditions without any adverse effect on its performance.

1.4. POWER SUPPLY CONDITIONS

- 1.4.1. Power shall be available at 415 volts, 3 phase, 50 Hz

- 1.4.1.1. The following voltages shall be used in the crane

1. $415 \pm 10\%$ volts. 3 phase $50 \pm 3\%$ Hz, A.C For drive motors.
2. $230 \pm 10\%$ volts. single phase $50 \pm 3\%$ Hz, A.C For lighting
3. $24 \text{ volts} \pm 10\%$, single phase 50 Hz $\pm 3\%$ A.C For hand lamp socket outlets
4. $110 \text{ volts} \pm 10\%$ single phase 50Hz $\pm 3\%$ A.C For control circuit and for floor operated crane as required by the consignee.

The voltage 2, 3 & 4 above shall be obtained through individual separate transformer units connected to 3 phase, 415 volts A.C. supply.

1.5. DOWN SHOP LEADS AND CURRENT COLLECTION GEAR SHROUDED BUS BAR CONDUCTOR

- 1.5.1. Insulated Shrouded Bus Bar Conductor shall be of M/s.INSUL-8 UK make or safe track brand of M/s.Sushil Engg. Corporation Mumbai or "Safeline" brand of M/s Stromag Engineers Limited, Mumbai or Silverline brand of M/s Sliver line Metal Engg. Pvt. Ltd., and shall conform to the following:
- 1.5.2. The conductor system shall be finger safe to IP-21 with necessary supporting technical evidence of same and the conductor and material shall be of suitable metal (Galvanized Iron up to 100Amps & copper above 100Amps) insulated by a high impact gloss finish VR 935/2 PVC compound which shall have a step/groove shrouded all along its length for effective moulding of the conductor system.
- 1.5.3. The conductor shall be in minimum 4 mtrs. Length to be jointed with moulded joint of the same material as the conductor and these conductors shall be supported by way of a single piece moulding, four pole hanger with single bolt fixing.
- 1.5.4. The current collector arm should be aluminum die cast totally insulated and the connection cable shall be fully enclosed and double insulated within the collector arm with a proven performance supported by documentary evidence.
- 1.5.5. The Voltage drop in full length of DSL should not be more than **2%**

1.6. MOTORS

1.6.1. FOR DOUBLE GIRDER CRANES:-

- 1.6.1.1. All crane motors should be of ABB, Crompton, BBL, Marathon, Siemens, Kirloskar make and totally enclosed fan cooled (TEFC) squirrel cage type and designed for 150 starts / hour. The motor shall be suitable for heavy duty crane hoisting service having cyclic duty factor not less than 40 % for class III and 60 % for class IV cranes. The motors shall be suitable for 50° C ambient temperature and 415 +/- 10% 50 Hz +/- 3%, 3 phase, 3 wire AC supply. The motor shall be generally conform to IS 325 (latest) and shall be 6 or 4 pole type. However, where IS specification is at variance with this specification, the provision made in this specification shall prevail.
- 1.6.1.2. The winding shall be of copper wire specially insulated and impregnated to with stand moist tropical climate and class of insulation shall not be less than 'B' class.
- 1.6.1.3. The motor shall be of adequate power, motor power requirement being computed as per Annexure 'C' of IS 3177-1999 (latest). Detailed motor power calculations shall be given in the offer. The motor should be rated for class S-4 duty. Derating factor for temperature and voltage variation if any shall be taken into consideration as per recommendations of the motor manufacturers. Technical details of motors along with control gear and electrical accessories shall be given as per schedule-III.
- 1.6.1.4. Type and routine test chart of motor selected shall be submitted to the inspecting authority during inspection.
- 1.6.1.5. Forced cooling shall be arranged by mounting suitably continuously run fan on all the motors for all motions.
- 1.6.1.6. **Horse Power**
The torque factor of longitudinal travel and cross traverse motors should be of the range of 1.3 to 1.5. The frame size of motor should be indicated in the offer. For selection of LT & CT motor sizes, longitudinal and cross traverse acceleration will be taken as 15 cm/sec.2 and 8cm/sec2 respectively.
- 1.6.1.7. All motors should be provided with insulation of class 'B' for stator and class 'F' for rotor. The maximum permissible winding temperatures measured by thermometer and resistance method shall not exceed 120 deg. C and 130 deg. C respectively.
- 1.6.1.8. The pull out torque of the motors at rated voltage and frequency range shall be as per IS: 3177- 1999 (latest).

1.7. TERMINAL BOX

The terminal box shall be provided on the top or front of the motor for easy accessibility. The cable sizes should be decided after considering derating due to grouping and ambient temperature of 50° C etc.

1.8. CRANE CONTROL

1.8.1. FOR PENDANT CONTROL CRANES ONLY:-

- 1.8.1.1. Pendant push button control station will be used for long travel, cross travel and hoist motions, for switching ON and OFF the motor of a particular motion. The supply voltage to the pendant control shall be 110V AC which

shall be obtained through a suitable transformer. Necessary flexible multicore cable with sufficient length shall be supplied to enable the crane to be operated from floor level. Pendant shall be moving type and the movement of pendant will be independent of trolley.

- 1.8.1.2. On all the motions the circuit shall be so designed that brakes come into operation immediately in the event of tripping of motor main circuit breaker.
- 1.8.1.3. The pendant control station shall be capable of withstanding rough handling without being damaged. The cover shall be firmly secured.
- 1.8.1.4. The mass of the pendant shall be supported independently of the electric cable by means of wire rope/chain. If the pendant is of metal, it should be effectively earthed.
- 1.8.1.5. On all pendant cranes safety means shall be provided to prevent inadvertent operation from floor while maintenance work is being carried out on the crane.
- 1.8.1.6. Adequate guards shall be provided to prevent accidental contact of pendant ropes or holding wire rope/chain with cross traverse.
- 1.8.1.7. Suitable arrangements shall be provided for automatically cutting off the resistances after a pre- selected time. The bidders shall explain the details in the offer.

1.8.2. FOR CABIN OPERATED CRANES:-

1.8.2.1. For all the motions spring return jockey switches or push button shall be used. **(Applicable for VVVF Drive Cranes)**

1.8.2.2. Two step two direction jockey switches in case of cabin control shall be used for all the motion.

- a) The rest position of jockey shall conform to zero position or off position.
- b) During running the rest position, means de-acceleration to stop.
- c) Step one at preset minimum speed of upto 10% of the maximum speed.
- d) Second step speed gradually accelerate to maximum speed.

Should a speed between minimum and maximum is desired, the operator shall return to step one and the same speed shall be maintained.

With the above system stepless speed shall be obtained.

Alternatively above features can be achieved by use of two push button control for each direction for all the motions. Tenderers to indicate the details of the proposed arrangement.

- 1.8.2.3. On all motions the circuit shall be so designed that brakes come into operation immediately in the event of tripping of motor main circuit breaks.
- 1.8.2.4. All controllers shall be so designed that the contacts and terminal arrangements are readily accessible for inspection and maintenance purpose.
- 1.8.2.5. Each controller shall be fitted with
 - i) Necessary steps for the forward and reverse motion to give smooth and stepless acceleration between each position.
 - ii) Auxiliary contacts to provide on interlock between the controller and circuit

breaker, so that the circuit breaker cannot be closed unless the controller is in off position.

- iii) Auxiliary contacts to provide an interlock with the limit switches, so that when the travel exceeds the safety limits, the motor circuit will be broken and the motor can only be allowed to reverse.

1.8.2.6. Controller in off position shall open all supply lines of the respective motors.

1.8.2.7. AC variable frequency control (VVVF) of adequate capacity for all the motions shall be used. Independent AC variable frequency control for main hoist, Aux. Hoist, CT & LT shall be used by using independent variable voltage variable frequency drives. However common controller for both the motors of LT may be used. Tenderer shall submit necessary details of the offered model as well as make confirmation for compliance as per clause 2.22 shall be submitted along with the bid.

1.8.2.8. Bidders shall submit the layout scheme of the operator's cabin showing the positions of various controls with respect to operator's seat.

1.9. CONTACTORS

1.9.1. All contactors shall be of AC-4 Class of duty or **AC-3 Class duty suitably derated for AC-4 class duty** with rating sufficiently higher than the full load current of the respective motors at the specified duty cycle. The directional contactors of all motions shall be suitably interlocked for correct sequence of operation. Electrical & mechanical life of the contactors shall be indicated. For AC 4 Class of duty or AC 3 Class duty suitably derated for AC-4 class duty, Electrical life shall be minimum 2, 00,000 cycles of operations.

1.9.2. The contactors shall have high contact reliability with preferably double break parallel bridge contact and facility of time saving termination.

1.9.3. All contactors shall be of L&T, Schneider, C&S, Siemens and Cutler Hammer make. Test certificate of the manufacturers shall be submitted in support of life and rating of the contactors.

1.10. RESISTORS (for slipping motors)

1.10.1. Resistors shall be adequately protected to prevent accidental contact.

1.10.2. The resistors shall be air-cooled, robust, heavy duty, Corrosion resistant stainless steel punched grid type. The resistance boxes shall be placed in racks or on the platform and shall be capable of independent removal of any selected box. Spacing recommended by the resistor manufacturer shall be maintained. The racks shall be robust in construction to withstand vibration due to crane operation. Wire wound resistors shall not be used on any motion of the crane.

1.10.3. All resistors shall be rated for 10 minutes continuous loading.

1.10.4. Resistors housing on cranes working in open yards shall be weather proof and on all cranes they shall be adequately protected. The electrical clearance between resistors and earthed metal shall not be less than 100mm. Cable terminal arrangement shall be such that cable cores do not get loose due to vibration.

1.10.5. The temperature of resistors shall not exceed 275 °C at specified duty.

1.11. CIRCUIT PROTECTIVE SWITCH GEAR

- 1.11.1. One triple pole manually operated moulded case circuit breaker (MCCB) make L&T, Schneider, C&S, Siemens, Havells, Cutler Hammer and ABB serving as main incoming protective device, fitted with no volt, short circuit and overload releases and rated to carry at least combined full load currents of the two motions of the crane having largest power should be provided. The circuit breaker shall have adequate rupturing capacity to withstand and clear fault current of the order of 30 KA. The circuit breaker shall have adequate rupturing capacity to withstand and clear fault near the protective panel, in such a way that adequate clearance is provided as per Indian Electricity Rules. In case of floor operated cranes instead of MCCB, push button operated contactor shall be provided, other provisions remaining unchanged.
- 1.11.2. The trip circuit of the circuit breaker shall be so designed such that it will prevent the circuit breaker from being enclosed when main contactor of any of the motions has failed to open, although the corresponding controller has been brought to OFF position. Suitable protective features to trip the circuit breaker with the operation of limit switches and emergency push buttons shall also be provided.
- 1.11.3. To indicate whether power and control sources are ON and whether any emergency switch has been operated, indicating lamps shall be provided in operator's cabin, in case of cabin operated cranes.
- 1.11.4. For protection of each drive motor against over loads adjustable inverse time lag manually reset electro-magnetic type relays shall be provided for each motor. Alternatively, electronic type relays shall be acceptable. These relays shall be mounted in respective contactor panels and shall be set to trip the circuit of motion being controlled when current exceeds 200% of normal value for more than 10 seconds. The control circuit of individual motions shall have off position interlock with respective master controllers.
- 1.11.5. Each motor feeder shall be protected with no volt trip device, HRC fuses against short circuit, and with instantaneous trip current sensitive type single phasing cum phase reversal preventor.
- 1.11.6. Isolating switches fitted with HRC fuses shall be provided for the following branch circuits:
 - a) Lighting and hand lamp socket outlets
 - b) Control circuit.

Both of the above mentioned isolators shall be installed in driver's cabin in case of cabin operated cranes.
- 1.11.7. Each control circuit branch to every contactor panel shall be provided with facility for isolation and protection against short circuits and sustained high overloads by means of appropriately rated miniature circuit breaker.
- 1.11.8. A triple pole isolating switch without fuse shall be provided on the long travel bridge walkway, as close as possible to the main current collectors. This shall isolate all the circuits except the crane lighting circuit.

1.12. LIMIT SWITCHES