Bharath Heavy Electricals Limited

Tiruchirapalli - 620 014.

Maintenance & Services

General Specification of Cranes

DECEMBER - 1999

TECHNICAL SPECIFICATION, DESIGN STANDARDS AND GENERAL DETAILS

01. The crane shall be designed in accordance with IS:3177/1999 for Class A5 / A6 duty.

02. For welded construction such as that of bridge girders, end carriages, trolley frames, rope drums, gear boxes etc, steel shall be of IS : 2062 quality.

03. Full length chequered plate platforms shall be provided on the top of both the bridge girders in order to have access to operators' cabin, long travel drive, current collectors, trolley, panels etc. The chequered plate platform shall cover the full length of main and auxiliary girders. The width of the chequered plate covering shall not be less than 750 mm.

04. Foot walks shall be of sufficient width to give at least 500mm clear passage at all points.

05. Where down shop leads are located below runway rails a guard shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads.

O6. Fasteners for pedestal blocks, motors., gear boxes etc.shall be of high tensile alloy steel material machined fit bolts and easily removable from the top of the platforms. Studs or body bound bolts shall not be used as fasteners for mechanical items except for fixing covers.

07. All cables shall be clamped individually. All trailing cables shall be clamped with PVC or non-metallic clamps. Drag chain / rope shall be provided for trailing cable trolleys.

08. Safety hand railings preferably of tubular constructions shall be provided on bridge foot walks, end carriages, staircase, landing in cabin trolley and in any other place where access has been provided. Railings shall not be less than 1000mm high.

09. Materials used for equipment /structural shall be free of fractures, cracks, blow holes, laminations pitting etc.

10. Sizes for all equipments viz. LT & CT wheels, brakes etc.shall be selected from preferred number series.

II. TECHNICAL SPECIFICATION --- STRUCTURAL DETAILS

01. GENERAL :

Crane structure shall be designed in accordance with the latest edition of IS-807 taking the following additions/deviations applicable, into account :

a) Unless otherwise specified only welded joints shall be used.
b) Black bolts shall not be used in the Crane.
c) Bolts used in shear shall be fitted into reamed holes.
d) All butt welds on main structural members shall be 100% X-rayed and proof shall be furnished for the same.
e) Cranes working in outdoors or in corrosive condition a corrosion allowance 1.5 mm shall be added to the thickness of the members required to resist all calculable stresses and the minimum thickness of the member shall however be not less than 10 mm.

f) Minimum thickness of chequered plates for platforms shall be 6mm in plain for indoor cranes and 8mm in plain for outdoor cranes.
g) Splice shall be designed to resist all the forces and moments to which it is subjected to, plus 50% thereof. However in no case the strength developed by the splice shall be less than 50% of the effective strength of the material spliced. Splices shall be proportioned and arranged so that the gravity axis of the splice is in line with the gravity axis of the members so as to avoid the eccentricity of the loading.

III. WIND LOAD

Unless otherwise specified, outdoor cranes shall be designed to operate under steady wind pressure of 25 Kg/mm2 over the total exposed area of the crane. For the purpose of calculating wind effect on the lifted load, the area of the load may be taken as 1 sq.mtr for every ton of load lifted. To calculate suitable wind load, the form factor can be taken from table 3 of IS 887/1976.

IV. STABILITY :

The stability of a crane under storm conditions shall be such that stabilizing moment is at least 1.25 times the overturning moment due to the maximum wind effects. The stability factor in any case shall not be less than 7.

V. BRIDGE GIRDERS :

The bridge girders shall be of box welded construction with double web plates. Girders shall be sufficiently strong and rigid to withstand the most severe combination of loads that may develop under different working conditions.

a) For box plate girders, in addition to the required full length diaphragms. short diaphragms shall be inserted where required to transmit the trolley wheel load to the web plates and to limit the maximum stress in the trolley rail within safe permissible stress. Stress in the rail shall be computed from the formula :

$$\text{Stress} = \frac{\text{Wheel load X distance between supporting diaphragms}}{\text{6 X section modules of rail}}$$

b) Full length wearing plates shall be provided under the trolley rails. The wearing plates shall be 10 mm thick and welded in place to the flange with minimum 5 mm continuous welds.

c) Girders shall be cambered an amount of equal to the deflection caused by dead load plus on half the live load and the trolley.

The bridges shall be deflect more than 1/900 of span with safe working load on the trolley with trolley stationed at mid span and excluding deflection due to dead load.

d) The bridge girders shall be connected to the end carriages by large gusset plates.

VI. LEG

Leg shall be of box type. The girder connection to the leg should be designed for double shear. The leg shall be connected to the end carriages by large gusset plates. The leg

should be fabricated as a single piece. Suitable hand holes shall be provided at the joint.

The fillet welding of the legs shall be full penetration joints in case of gantry crane.When there is no faciliity to test the crane in fully assembled condition, the legs and girders, leg & end carriages shall be separately assembled for perfect alignment to avoid any twist in the legs. The gap between joint should not be more than **3 mm.**

The spliced plates shall be one inside and other outside to cover the main member. The holes shall be reamed in such a way that the bolts shall be inserted by light hammering. The spliced joints shall be marked for easy identification.

VII. END CARRIAGES :

End carriages shall be fabricated from rolled steel sections or plates, or both welded together to form a box, except for essential openings which shall be reinforced.

The length of the end carriages shall be such that no other part of the crane is damaged in collision.

The wheel base shall not be less than 1/5 th of the span. In case the end carriages has more than two wheels, the wheel base shall be taken as the distance between the centers of the outside wheels.

The end carriages shall be fitted with substantial safety stops to prevent the crane from falling more than 25 mm in the event of breakage of a track wheel, bogies, or axle. These safety stops shall not interfere with the removal of wheels.

Suitable jacking pads at a height of 300 mm from rail level shall be provided on each end carriage for jacking up the crane when changing the track wheels. Jacking pads shall not interfere with the replacement of track wheels.

VIII. TROLLEY FRAME :

Trolley frame shall be produced in one piece unless there are transport limitations. Drum bearing and supports for upper sheaves shall be located so as to equalize the load on the trolley wheels as nearly as possible.

The trolley frame shall be arranged to afford maximum accessibility for maintenance to mechanical and electrical parts placed on it.

It shall be designed such that at the highest position of hook there shall be a clear distance of 1000 mm between the lowest point of trolley obstruction and the highest point of bottom block. Deviation shall be made only with specific approval of purchaser.

The top of the trolley frame shall be plated all over except for openings required for the ropes and flexible cables for bottom block etc.to pass. All mechanical and electrical equipment shall be placed above the trolley top plate as far as practicable. For any parts placed below the trolley top plate, access for maintenance, repair, lubrication and replacement shall be provided.

The trolley shall be fitted with substantial Safety stops to prevent the trolley from falling more than 25mm in the event of breakage of a track wheel, bogie, or an axle. This safety stops

shall not interfere with the removal of wheels. Suitable jacking pads at a height of 300 mm from the rail level shall be provided on each corner for changing the wheels. Jack pads shall not interfere with the replacement of wheels.

IX. TROLLEY RAIL :

Trolley track rails made of rail steel shall be clamped to the girders with cup type clamps spaced not more than 900 mm apart with welded alignment blocks between every two clamps such that the distance of a clamp from any adjacent alignment block shall not be more than 450 mm. Rails shall be prevented from creeping in the longitudinal direction by rail stops, riveted or welded. Rails shall be made continuous by welding standard lengths. Only crane rail shall be used.

X. REPAIR CAGES :

Repair cage shall be provided on the inside of the end carriage for attending to the current collectors. Repair cages shall also be provided at the corners of the crane, if required, to facilitate removal of long travel wheels. The repair cages shall be minimum 1000 mm wide and shall be such that two persons can work comfortably in the space provided. The floor of the repair cages shall be 1500 mm below the LT wheel centers except the one on which the main current collectors are mounted, where it shall be suitably adjusted.

TECHNICAL SPECIFICATION ----- MECHANICAL DETAILS

XI.DESIGN PROCEDURE :

GENERAL:

Mechanism components shall be proportioned by checking that they have adequate safety against becoming unserviceable as a result of single combination of extreme loading conditions causing fracture, bending or other type of failures. They shall also be checked whenever appropriate against fatigue, deflection or over heating. In this connection, consideration shall be given to the consequences of failure.

For example, failure in hoisting mechanism component is usually more dangerous than failure of a horizontal motion mechanism.

XI. 1.Basis of design :

Mechanism components shall be checked depending on the ultimate strength by verifying that the calculated stress does not exceed a permissible dependent on the breaking strength of the material used.

XI. 2 Permissible stress

Mechanism component shall be checked for strength under case I, II, III & IV loading conditions and load combinations specified in IS. The value of the permissible stress Fa is given by following formula where unit of stress was defined as N/mm^2

$$F_a = \frac{F_{ult}}{C_{df} \times C_{bf} \times C_{sf}}$$

where

F_{ult} = ultimate tensile strength of the material

C_{df} = duty factor for the appropriate mechanism class. For the values refer IS

C_{bf} = basic stress factor corresponding to each case of loading. For the values refer IS

C_{sf} = safety factor depending on the material used. For the values refer IS.

Table - 2 Values of Co-efficient, C_{df}

Group classification of Mechanism	For mechanism used for Horizontal motion	For mechanism used for vertical motion	For mechanism used for vertimotion with people or while handling. Dangerous for Example Molten Metals highly radio active or corrosive products
M 1	1.00	1.18	1.32
M 2	1.06	1.25	1.40
M 3	1.12	1.32	1.50
M 4	1.18	1.40	1.60
M 5	1.25	1.50	1.70
M 6	1.32	1.60	1.80
M 7	1.40	1.60	1.90
M 8	1.50	1.70	2.00

Table 3 - Values of Co-efficient, C_{bf}

Case of loading	I	II	III and IV
C_{bf}	3.15	2.5	2.0

Table 4 - Values of Co-efficient, C_{sf}

For ordinary grey cast iron or for cast or forged components where blow holes or internal cracks can not be detected	1.25
For mild steel Fe 310 & Fe410	1.12
For other materials Fe44 & Fe57, etc.	1.00

XI.3 Relation between calculated and permissible stresses

According to the type of loading to be considered the following relations shall be verified

a) Pure tension $1.25\ f_t \leq F_a$

b) Pure compression $f_c \leq F_a$

c) Pure bending either compression or tension f_{bt} or $f_{bc} \leq F_a$

d) Combined bending and tension $1.25\ f_t + f_{bt} \leq F_a$

e) Combined bending and compression $f_c + f_{bc} \leq F_a$

f) Pure shear $\sqrt{3 f_s \leq f_a}$

g) combined bending, tension and shear

$$\sqrt{[(1.25\ f_t + f_{bt})^2 + 3f^2] \leq F_a}$$

h) combined bending, compression and shear

$$\sqrt{[(f_c + f_{bc})^2 + 3f^2] \leq F_a}$$

where

f_t = calculated axial tensile stress
f_c = calculated axial compressive stress
f_{bt} = calculated maximum tensile stress due to bending about both principal axes
f_{bc} = calculated maximum compressive stress due to bending about both principal axes, and
f_s = calculated shear stress

XI.4 Checking for fatigue

XI.4.1 General

Where it is necessary to check a component for fatigue , recognised techniques available for calculation of fatigue properties shall be used. The choice of the methods used shall be left to the manufacturer, however he shall specify the origin of the methods to be adopted if asked by the customer.

XI.4.2 Loading condition

Case I of loading condition as specified in IS shall be used as the basis for all fatigue checks.

XI.4.3 Stresses

The following characteristics shall be determined for each type of fluctuating stress, for example tension, compression, bending or shear; occurring during an appropriate stress cycle in the component detail having regard to the loading that it will experience.

f_{Max}, f_{Min} = extreme values of stress occurring in the stress cycle

f_{Min} = considered as negative if it its of opposite sense to f_{Max}

P_{fb} = permissible fatigue stress in bending

P_{fs} = permissible fatigue stress in shear

P_{fr} = fatigue reference stress at which a component detail has a 90% probability of survival

$f_{a\,Max}$, $f_{a\,Min}$ = extreme values of axial tensile stress

$f_{b\,Max}$, $f_{b\,Min}$ = extreme values of stress in bending.

$f_{s\,Max}$, $f_{s\,Min}$ = extreme values of torsional shear stress

f_{Min} / f_{Max} = maximum degree of stress fluctuation

XI.4.4 Permissible fatigue stress

The permissible fatigue stress "pt" for each type of stress, for example tension, bending or shear is given by :

$P_f = 0.8\ P_{fr}$ for hoisting mechanisms

$= 0.85\ P_{fr}$ for all other mechanisms

where the component detail is subjected to a single type of fluctuating stress that is f_{Max} shall not exceed P_f the permissible fatigue stress.

The stress combination occurring most frequently in practice in a component detail is that of bending and torsion. The details subjected to this combination shall be designed so that :

$$\left[\frac{f_{b\,Max}}{P_{fb}}\right]^2 + \left[\frac{f_{s\,Max}}{P_{fs}}\right]^2 < 1.0$$

XI.4.5 Checking for crippling

Component subjected to crippling that is overall flexural buckling due to axial compression shall be checked so that the calculated stress does not exceed a limit stress determined as a function of critical stress above which there is a risk crippling occurring. For this check co-efficient C_{df} as given in Table 2 shall be taken into account.

XI.4.6 Checking for wear

In case the parts subjected to wear, the specific physical quantities such as surface pressure or the circumferential velocity must the determined. The figures must be such that on the basis of present experience they will not lead to excessive wear.

XII ROPE DRUM

XII.1 General

Drums shall be designed for single layer of ropes only.

XII.2 Length of Drum

The drum shall be of length that each lead of wire rope has a minimum of two full turns on the drum when hook is at its lowest position not tacking into consideration the turns covered by the wire rope anchorage and one spare groove for each lead of the wire rope on the drum when hook is at its highest position.

In the case where the drum flanges are not provided, a free length not less than 4 times to the diameter of the wire rope or 100 mm whichever is more is to be provided beyond the last groove center line at the anchorage point.

XII.3 Lead Angle

The lead angle of the rope shall not exceed 5° on either side of helix angle of the groove in the drum.

XII.4 Grooving of the drum

Rope drums shall have machined grooves and the contour at the bottom of the grooves shall be circular over a minimum angle of 120°.

Grooving shall be finished smooth and shall be free from surface defects likely to injure the wire rope. The edges between the grooves shall be rounded. The radius of the groove shall be between 0.53 to 0.59 times the diameter of the wire rope rounded off upwards to the nearest 0.5 mm. The depth of the groove shall not be less than 0.3 times the diameter of the wire ropes for drum with **single layer** of the wire rope. The pitch of the grooves of the drum shall not be less than 1.08 times the diameter of the wire rope for the drum with **single layer** of the wire rope.

XII.5 Diameter of the Drum

The diameter of the drums at the bottom of the groove shall be standardized to sizes 200, 250, 315 ,400, 500, 630, 710, 800, 900, 1000 and 1250 mm.

The diameter of the drum measured at the bottom of the groove shall be not less than the value calculated as follows.

$$D_d = 12 \times d \times C_{df} \times C_{rc}$$

Where

D_d = diameter of the drum measured at the bottom of the groove, in mm.

d = calculated diameter of the rope, in mm:

C_{df} = duty factor for hoisting for the appropriate mechanism class as defined in XI.2: and

C_{rc} = factor dependent on the construction of wire rope.

For wire rope construction:

6 x 36 or 6 x 37 $C_{rc} = 1.0$,

6 x 24 $C_{rc} = 1.12$,

6 x 19 $C_{rc} = 1.25$.

XII.6 Material for the Drum

Drums shall be made of seamless pipe as per ASTM A 106 GR A and B, cast iron of minimum Grade 25, Cast steel, rolled steel of welded construction and in case of welded drum this should be stress relieved.

XII.7 Strength of the Drum

Drums shall be designed to withstand the compressive stress caused by the wound of wire rope, bending stress due to beam action and torsional stress.

XII.8 Rope Anchorage

The end of the wire rope shall be anchored to the drum in such a way that the anchorage is readily accessible. Each wire rope shall have not less than two full turns on the drums when the hook is at the lowest position not taking into consideration the turns covered by the wire rope anchorage.

XIII. WIRE ROPE

XIII.1 General

Hoisting rope shall conform to IS 2266. Rope shall be of FMC, 6x37 construction.

XIII.2 selection procedure

The selection procedure adopted here assumes that the ropes are lubricated correctly, that the winding diameters on the pulleys and drum are selected in correspondence with this standard.

a) group classification of the mechanism,

b) the rope receiving system employed and its efficiency,

c) rope inclination at the upper extreme position of the hook, if the rope inclination with respect to hoist axis exceeds 22.5°

The minimum breaking load F_o of the rope intended for a particular duty shall be determined from the formula given below, however impact factor should not be considered while calculating the rope tension.

$$F_o = S \times Z_{zp} \times C_{df}$$

Where

S = maximum rope tension considering inclination of the rope in the uppermost position.

Z_p = minimum particle co-efficient of utilization. For normal condition Z_p shall be taken equal to 6.0.

C_{df} = duty factor for hoisting as defined in Table 2

XIV. SHEAVES

XIV.1 Grooving

Sheave shall have machined groove. The contour at the bottom of the groove shall be circular over a minimum angle of 120° and shall have an included angle of 50°. The grooves shall be finished smooth and shall be free from surface defects likely to injure the wire rope. The depth of the groove shall not be less than 1.5 times the diameter of the rope. The radius of the groove shall be between 0.53 to 0.59 times the diameter of the wire rope rounded upwards to the nearest 0.5 mm.

XIV.2 Diameter of the Sheaves.

The diameter of the sheave measured at the bottom of the groove shall not be less than that at the drums. The diameter of the bottom of the groove at an equalizing sheave shall not be less than 62 percent at the minimum sheave diameter.

The value is calculated as follows:

$D_s = 12 \times d \times C_{df} \times C_{rc} \times C_{rr}$

$D_s = 8 \times d \times C_{df} \times C_{rc}$ for equalizing sheave.

Where

D_s = diameter of the sheave measured at the bottom of the groove in mm,

d = diameter of the rope,

C_{df} = duty factor for the appropriate mechanism class as defined in XI.2 for hoisting,

C_{rc} = factor dependent on the construction of the rope as defined in XII.4 ,and

C_{rr} = co-efficient depending upon the type of receiving system.

For sheaves the value of the co-efficient C_{rr} depends upon the number of pulleys in the reeving and the number of reverse bends.

Taking the values of

N_b = 1 for a drum,

N_b = 2 for a pulley carrying the rope in the same direction of wrap (no reverse bend),

N_b = 3 for pulley carrying the rope in the reverse direction of wrap (reverse bend),

N_b = 0 for compensating pulley, and

N_t = is the sum of these values of N_b for the given rope reeving.

The corresponding values of the co-efficient 'C_{rr}' are given in Table 5.

N_t	<5	6 to 9	≥10
C_{rr}	1	1.12	1.25

XIV.3 Lead Angle

The angle between the wire rope and a plain perpendicular to the axis of the pulley shall not exceed 5°

XIV.4 Material

Sheaves shall be manufactured from cast steel, or forged steel or rolled steel

XIV.5 Sheave Guards

Sheaves shall be provided with rigid guards to retain the wire ropes in the grooves. The guards shall fit close to the flange having a clearance not more than one fourth of the diameter of the wire rope between the sheave and the inside of the guard. Bottom block sheaves shall be enclosed except for wire rope openings.

XV. TRACK WHEELS.

XV.1 General

Track wheels shall have cylindrical treads with flanges to guide the crab or the crane effectively to prevent derailment. The wheels shall be mounted in such a manner as to facilitate easy removal and replacement. This clause gives criteria for determining the size of the wheels required to meet a particular duty. It is assumed here that the rail track is maintained in good condition and that the wheels are correctly aligned.

XV.2 Design Factors

The factor those need to be considered when determining the required material and diameter for rail wheels are as follows when:

a) load on the wheel,

b) type and the material of the rail,

c) speed of rotation of the wheel(n),

d) length of travel (L) on the rail and number of load carrying wheels (Z) operating on the same length of rail, and

e) group classification of the mechanism.

XV.3 Wheel Hardness

The minimum hardness of the wheel rim should be maintained 300 to 350 BHN with minimum depth of 10 mm. The formula for determination of wheel hardness is as follows:

$$BH_W = \frac{1.3 \times BH_r \times C_L}{C_Z \times C_d}$$

Where

BH_W = Brinnel hardness of the wheel rim;

BH_r = Brinnel hardness of the rail;

C_L = factor dependent on the rail length 'L' used by 'Z' number of wheels. For values refer 6.

C_Z = factor dependent on the number of load carrying wheels 'Z' For values refer Table 7;

C_d = factor dependent on the wheel diameter 'D' For values refer Table 8.

Table 6 Values of Co-efficient C_L

Length in mm	C_L
10	1.00
16	1.05
20	1.08
25	1.11
31.5	1.14
40	1.17
50	1.20
63	1.23
80	1.26
100	1.29

Table 7 Values of Co-efficient C_Z

Z in Nos. m	C_Z
2	1.00
4	1.08
6	1.13
8	1.17
10	1.20
12	1.22
14	1.24
16	1.26

XV.4 Material

The material for the track wheels should be of C-55Mn 75

XV.5 Loading Conditions

In assessing the individual loadings arising under Case I and Case II loading conditions, the hook load impact factor is not applied.

XV.6 Diameter of Wheels

The diameter of wheels shall be standardized to sizes 160, 200, 250, 315, 400, 500, 630, 710, 800, 900, 1000 and 1250 mm. The use of wheels of diameter greater than 1250 mm is not recommended. The minimum tread diameter of the wheel may be calculated from either of the formula given below:

$$D = \frac{1.5W}{a} \quad \text{or}$$

$$D = \frac{W \times C_{df} \times C_{sf}}{1.5a \times C_{bh} \times C_{sb}}$$

Table 8 Values of Co-efficient C_d

Diameter in mm	C_d
160	1.00
200	1.03
250	1.06
315	1.09
400	1.12
500	1.15
630	1.18
710	1.21
800	1.21
900	1.24
1000	1.24
1250	1.27

Table 9 Co-efficient C_{bh}

B_{hw}	F_{ult}	C_{bh}
125	415	1.00
140	470	1.40
160	540	1.90
180	605	2.50
200	680	3.15
224	760	4.05
250	845	5.30
280	950	6.70
315	1065	8.65
355	1200	11.20
400	1355	14.50
450	1530	18.70
500	1725	23.20
560	1950	29.50

Table 10 Values of Co-efficient C_{sp}

Rotational Speed in mm	C_{sp}
200	0.66
160	0.72
125	0.77
112	0.79
100	0.82
90	0.84
80	0.87
71	0.89
63	0.91
56	0.92
50	0.94
45	0.96
40	0.97
35.5	0.99
31.5	1.00
28.0	1.02
25.0	1.03
22.4	1.04
20.0	1.06
18.0	1.07
16.0	1.09
14.0	1.10
12.5	1.11
11.2	1.12
10.0	1.13
8.0	1.14
6.3	1.15
5.6	1.16
5.0	1.17

Where
D = tread diameter of the wheel in mm,

W = mean wheel load in Newton's,

a = useful width of rail,

C_{df} = duty factor for the appropriate mechanism class as per Table 2.

C_{bh} = hardness factor for the wheel material. For values refer Table 9. Here wheel hardness

B_{hw} = as calculated in shall be used even if wheel rim if hardened more for longer wheel life

C_{sf} = safety factor depending on the material used, and

C_{sp} = co-efficient depending on the speed of rotation of the wheel as defined in Table 10.

For a rail with a total head 'B' having rounded corners of radius r at each side and having:

a) Flat bearing surface a = B-2r

b) Convex bearing surface a = B-4r/3

Where
B= head width of the rail, and

r= radius of the rounded corners of the side.

XV.7 Determination of the Maximum Static Wheel Loading 'P_s'

Where this shall be the maximum wheel load occurring with the wheel static upon the rail in any of the four cases of loading.

XV.8 Determination of the Mean Wheel Loading

For loading conditions of 'normal service without wind' and' normal service with wind' a mean wheel load shall be determined from the relationship by the formula given below:

$$P_{mean} = \frac{2P_{Max} + P_{Min}}{3}$$

XV.8 Flanges

The dimension of flanges for guiding track wheels at the base shall not be less than the values given in Table .11

Table 11 Minimum Flange Dimensions
(All dimensions in millimeters)

Diameter of wheels	Depth of flange	Thickness of flange
160, 200, 250	16	16
315, 400, 500	20	20
630, 710, 800, 900, 1000	25	25
1250	30	30

XV.10 Width of Tread

The width of the wheel tread shall be greater than the rail head by an amount which shall suitably allow for the variations in the gantry rail alignment, gantry track span dimensions and crane span dimensions.

XV.11 Adhesion of the Drive Wheels

To eliminate slipping of the drive wheels of the travelling mechanism of the crane or crab, the design shall be checked or adhesion under the most unfavorable combination of loads producing maximum and minimum loads on the drive wheels. The co-efficient of adhesion (friction) shall be taken as 0.15 for dry rails and 0.1 for damp rails.

XVI. BUFFERS

XVI.1 General

Suitable buffers shall be fitted to each end of the end carriage assemblies and on both sides of crab or the bridge.

Buffers shall be so mounted to permit easy removal of wheels. Limit switches shall be provided in such a way that drive motors are switched off before the buffers are pressed. Buffers will be provided between the cranes if more than one crane is running on the same track.

XVI.2 Type of Buffers

Spring buffers, hydraulic buffers and buffers made out of resilient plastic, rubber or polyurethane may be used. Wooden buffers shall not be used. Buffers shall have sufficient energy absorbing capacity to bring the loaded crane or crab to rest from a speed 50 percent of the rated speed at a deceleration rate not exceeding 5 m/s^2.

XVII Gearing

XVII.1 General

All gears shall be machine cut hardened and profile ground and shall confirm to relevant Indian Standards. However the crane gearings can be designed on the basis of the conditions given below :

a) Service experience under conditions corresponding to the classification parameters involved, or
b) other recognized standards or codes which have been proved satisfactory in crane service or
c) any other method for making calculations where manufacturer must indicate origin of the method adopted if asked by the purchaser.

The gearing shall be designed for a service life compatible with the service life of the mechanism, the class of utilization and state of loading used for the mechanism, and having regard to the prime mover and brake.

XVII.2 Material

All gears shall be of cast or wrought or forged from low/medium carbon alloy steel and suitably heat treated.

XVII.3 Gear boxes

A pair of gears shall be so except for planetary gear boxes helical shall be automatically oil lubricated. The first pair of gears shall always be helical. The gears shall be readily removable and the boxes shall be oil tight. They shall be of rigid construction and fitted with inspection covers and lifting lugs where necessary. The inspection covers shall be so positioned that the first and second pinion shafts can be inspected. Minimum and maximum oil lever indicators and facilities for oil filling, oil drainage and air breathing shall be provided.

All gear boxes shall be in totally enclosed construction. Teeth shall be machine cut, ground, suitably hardened and tempered and shall conform to AGMA or IS 4460. The surface hardness of pinion shall be between 266 to 300 BHN and that for gear shall be between 217 to 255 BHN. Difference or hardness of pinion and gear must not be less than 20 BHN.

The gear box shall be machined and shall be seated and positively located on machined surface.

Material of the gear box shall be cast, fabricated alloy steel. The fabricated gear boxes shall be stress relieved before machining. The internal surfaces of the gear box shall be painted with oil resisting paint.

XVIII Bearings

XVIII.1 General

Bearing pedestals and mounting shall be capable of transmitting the load from the bearing to the supporting structure. Suitable provision shall be made for those cases where the resultant load is not acting as a compression load on a bed plate. Suitable anti-friction bearings shall be used for live or fixed axles for wheels, for the shafts used for sheaves and drums and for the shafts supporting gears.

Suitable bushing shall be used in bogies. Steel bush bearings made out of Phosphor bronze, cast iron or nylon can be used for hinges or balancers of crane bridge or trolley, cross beams for hooks, magnet suspension, links for grab bucket and at places where rotation is not powered.

XVIII.2 Anti-friction bearings

Anti-friction bearings shall be installed and fitted in accordance with the manufacturer's procedures with adequate provision for lubrication.

Arrangements for axial location shall be in accordance with correct practice so that the unforeseen additional bearing loads are not induced. Bearings shall be capable of withstanding the greatest static and or dynamic load it can be subjected to under the most unfavourable conditions. The bearings shall have minimum static load capacity F_{sb} for a particular duty given below:

$$F_{sb} = P \times C_{df}$$

where

P = maximum static load on the bearing under any load condition and for the equivalent load to be determined as specified by the manufacturer.

C_{df} = duty factor as defined in Life of the anti-friction bearings shall be calculated in accordance with the manufacturer's recommendations and based on working hours specified for the duty of the mechanism.

XVIII.3 Plain bearings

The selection, fitting, lubrication, the pressure and rubbing velocity shall be in accordance with the recommended practice and service experience for the material involved having regard to the nature of the loads and operating conditions. Plain bearings shall, where practicable, be of the adjustable cap type. If Phosphor bronze bearings are used the pressure shall not exceed 6,86 MPa is the unit of pressure.

XVIII.4 Lubrication

Provision shall be made for the service lubrication of all the bearings unless sealed and lubricated for life. Ball and roller bearings shall, in addition, be suitably lubricated before assembly.

XIX Couplings

All couplings shall be of cast, wrought or from forged steel, tooth portion to be heat treated to hardness HB 241-280 and also shall be designed to suit the maximum torque that may be developed. Solid and flexible couplings shall be aligned with the same accuracy so that they match accurately.

Hoist drums shall be connected to gear box output shaft by means of flexible drum couplings or barrel couplings to cater for misalignment, frame distortions, etc and also to facilitate removal of hoist drum. Shaft couplings shall be as near as practicable to the bearings.

XX Fasteners

XX.1 Keys

Keys and key-way shall conform to relevant Indian Standards. Keys shall be so fitted and secured that they cannot work loose in service.

XX.2 Bolts, nuts, screws and washers

All bolts, screws and set screws in rotating parts shall be locked. All other bolts and screws shall be fitted and locked if required so that they do not get loose. Bolts in tension shall be avoided wherever possible. All bolts, screws, nuts shall be made out of high tensile alloy material and shall be in accordance with relevant Indian Standards. Black bolts shall not be used. All bolts and nuts shall be easily accessible.

Tapered washers and tapered pads when used shall be tack welded in place. All washers shall conform to IS 1364 and IS 1367 respectively.

XXI. Lifting Hooks

XXI. 1 General

Lifting hooks shall comply with IS 3815 & IS 5749

XXI.1.1 Types

For loads up to and less than 50 ton, shank type plain hooks be used. For loads of 50 ton and over hooks of Rams horn type or triangular lifting eyes are to be preferred.

Hook, hook with hook latch is to be provided with closing fingers to prevent slippage of load and the risk of displacement of load during hoisting and for lowering operation. "C" type hook shall be used. In this case the hinge lug for the closing finger shall be forged with the hook. The finger shall be capable of taking load equal to 1.5 times of the weight of the hook block without distortion in accordance with IS 13870 (Part I).

XXI.1.2 Mounting

Swiveling hooks shall be mounted on anti-friction thrust bearings. A protective skirt shall be provided to enclose the bearings. The thrust bearings shall be provided with facilities for lubrication. A locking device shall be fitted to prevent rotation of hook wherever necessary.

XXII Braking

XXII.1 General

a) The parts used for braking shall be made from hard wearing material with adequate thermal capacity for the duty required. Due allowance shall be kept for the brake drum capacity to dissipate heat generated due to frequent braking. The rubbing surface shall be smooth and free from defects. The brake lining shall be protected from water, grease, oil or other adverse effects.

b) The bearing pressure on the linings shall be conducive to uniform breaking and long life. Brakes shall be provided with means of adjustment to compensate for wear.

c) All electro-mechanical or electro-hydraulic brakes shall be applied automatically by springs or weights when the power supply to the brake is interrupted or when the circuit breaker is opened or when the controller is brought to off position. Power applied brakes shall not be fitted without a back system of power released type and without prior approval of the purchaser.

d) Springs of electro-mechanical brakes shall be of the compression type and shall not be stressed in excess of 80 percent of the elastic limit of the material. Brake weights if provided shall be securely bolted to the levers and locked.

e) Under service conditions brakes applied by hand shall not require a force greater than 120 N (12 Kgf) at the handle. Brakes applied by foot shall not require a force of more than 200 N (20 kgf) on the pedals. The stroke of hand levers shall not exceed 300 mm and of pedals 150 mm. Locking devices shall be provided on brake levers where necessary. Brake pedals shall have non slip surface.

f) Appropriate mechanical, electro-hydraulic magnet or any other alternative brake releasing gear may be used.

XXII.2 Braking Path

The braking path of the crane motions shall be within the distance as calculated from the following formula with all the brakes applied simultaneously.

$$S = \frac{V}{C_b \times C_{df}}$$

Where

S = braking path in metres,

V = speed of motion in metres/minute,

C_{df} = co-efficient for group classification and type of motion as defined in XI.2,and

C_b = 80 for hoisting motions,
= 20 for travel motions.

XXII.3 Hoist Motion Brake

All electrically operated hoisting motion shall be fitted with an electro-hydraulic/electro-magnetic fail safe brake. The brake will arrest the motion and hold at rest any load up to and including overload test load at any position of the lift.

The provision shall be made to enable any load capable of over coming the friction in the system up to and including the test load to be lowered safely in a controlled manner in the event of power failure. The brake shall be designed to exert a restraining torque of minimum 50 percent greater than the maximum torque transmitted to the brake from the suspended load under the loading conditions as specified. In estimating this torque the effects of friction in the transmissions system between the load and the brake shall be ignored.

Total Torque of the extremely applied brakes, acting simultaneously, shall not be more than the total pull out torque of the motors.

XXII.4 Travelling motion

Every electrically operated traveling motion shall be fitted with a mechanical or hydraulic brake or an automatic electro-magnetic / Electro-hydraulic brake or a combination of the two, if required. The brake shall be capable of bringing a fully loaded crane to rest with least possible shock from the highest speed it can attain with electro-magnetic / electro-hydraulic brakes, limit switches shall be provided in this motion.

The traveling motion of every electric outdoor crane shall be provided with the automatic electro-magnetic parking brakes in addition to the service brake. All overhead cranes working outdoors shall be provided with an additional storm brake for anchoring it when it is left unattended or under the storm condition. Gantry cranes working outdoors with rails on ground shall be provided with rail clamps or screws jack at each corner for anchoring it during the storm.

The braking torque shall not be less than the full load torque transmitted to the brake and shall not be more than the pullout torque of the motor.

XXII.5 Traversing motion

The cross traverse motion should also necessarily be provided with brake/brakes as specified for long travel motion. When electro-mechanical brakes are provided, end limit switches shall be provided in this motion.

The cross traverse motion brakes(s) shall be capable of bringing the fully loaded crab to rest with least possible shock from highest speed it can attain.

The braking torque shall not be less than the full load torque transmitted to the brake and shall not be more than the pullout torque of the motor.

IXIA. SHAFTS

XXIII.1 Material

All shaft shall be made of steel. Shafts and axles shall have ample strength, rigidity and adequate bearing surfaces. Suitable surface finish for stressed portions of the shafts shall be selected having regard to size, stress levels, severity of stress raising features and the needs of bearings, seals etc. Adequate allowances shall be made for the effective losses in section due to key-ways, splines, etc. Large changes in the section shall be avoided with fillets of as large of radius as possible and/or be suitably tapered. All shafts shall be supported on minimum two bearings. Splines and serrations shall comply with relevant Indian Standards.

The travel driving shaft or shafts shall be supported on self aligning bearings at a distance so that the deflection due to the self weight of the shaft is between 0.03 to 0.05 percent or unsupported length of the shaft. Angular deflection of the line shaft at torque corresponding to 1.5 times the motor torque during acceleration period shall not be more than 0.25^2per meter of shaft length. Each part of the drive shaft shall be designed to transmit maximum torque due to the most unfavourable load position.

XXIV Lubrication

Provision shall be made for lubricating all bearings unless sealed or lubricated for life, matting gears and chain and sprockets arrangements. Where necessary easy access shall be provided.

In centralized lubrication system provision shall be made at the bearings to vent the lubricant pressure.

Lubricating nipples, pipes, and adopters shall generally comply with the relevant Indian Standards.

A lubricating chart shall be provided indicating all the lubricating points with "Red colour" paint, the type of lubricant and recommended frequency of lubrication.

XXV Guarding and weather protection

XXV.1 Guards

All gears, wheels, pinions and chain drives shall be totally encased by the guard or by the structure of the crane, so as to be safe as if complete encasement is provided. Effective guards shall be provided for all revolving shafts and couplings rotating at high speeds or having protruding parts or are so situated in relation to the structure of the crane as to be safe as if guards were provided. The sheaves of the hook block shall be guarded to prevent the possibility of trapping between sheaves and in-running wire rope.

Suitable guards shall be provided on the down-shop lead side to prevent accident contact between wire ropes or hook block or lifting attachments and live conductors. it is also suggested that all guards and protective equipment shall be painted in "Golden Yellow" or as in confirmation to relevant Indian Standards. This is required to identify about the location of the guards and protective equipment in the crane easily for the replacement of the guards/protective equipment while commissioning or while the crane is taken up for maintenance work.

XXV.2 Weather protection

For outdoor crane all electrical and mechanical equipments shall be adequately protected from the weather. All weather proof covers shall be easily removable. Total covering shall be provided for the trolley.

XXV.3 Painting

Before despatch of the crane, the complete crane covering structural, mechanical and electrical parts shall be thoroughly cleaned of all dirt, grease, scale and rust by shot blasting or chemical cleaning methods. A single coat of primer shall be given to all parts. At least two additional finishing coats of paint for indoor cranes/ outdoor cranes of colour of **Tractor orange / Yellow** respectively shall be given on all primer painted surfaces. Electrical panels, motors, brakes etc. shall be painted with **smoke grey** colour.

All moving parts up to the height of 5.0 M from working level or ground level shall be painted in "Golden yellow" colour. The bright exposed parts of the crane shall be given one coat of rust inhibitor. Interior of all gear boxes shall be painted with one coat of oil resisting paint. Areas that are inaccessible after assembly or erection shall be treated before assembly or erection.

XXVI Means of Access

XXVI.1 General requirements

In front of the panel the working place shall be minimum of 500mm or width of the door of the panel whichever is more. Safe means of access shall be provided to the drive's cabin and to every place where any person engaged on the inspection, repair and lubrication of the crane will be called upon to work; adequate handholds and footholds shall provided where necessary.

XXVI.2 Platforms

Every platform shall be securely fenced with double tiered guard rails having a minimum height 1.1 m and toe boards, unless parts of the crane structure provided safely. The platform normal width with only check plates shall be of sufficient to enable normal maintenance work to be carried out safely. On bridge platform, which shall be not less than 0.75m in normal width, the fencing shall extend along the full length of the outer edge.

Guard rails on the crab side of the bridge platform may be provided, if required.

XXVI.3 Ladders

Side of ladders normal width with only check plates preferably from platform to the cabin shall extend to a reasonable distance above the platforms or other reliable handholds shall be provided. Ladders shall if possible, slope forward. Vertical ladders exceeding 3m in length shall be provided with back safety guards.

TECHNICAL SPECIFICATION - ELECTRICAL

XXVII MOTORS

XXVII.1 General

The motors shall be selected to take care of loading conditions to suit the duty of the mechanism in which it is used. The motors shall be suitable for frequent reversing, frequent acceleration and braking.

XXVII.2 Selection of Motor sizes

When the duty cycle can be adequately assessed, AC motors for any crane motion may be selected so that the motor temperature in actual service shall not exceed the permissible limits specified in IS 325 for the 3 phase induction motors or other relevant Indian Standards (see Annex F of IS), taking into account the class of insulation adopted and the ambient temperature at the crane location. When duty cycle can not be assessed the recommended assumptions and design proceedings are set out in Annex C of IS for the selection of motors to suit duty cycles and normal service conditions.

AC motors shall be squirrel cage or slip ring induction type unless specified otherwise. It is necessary to know the torques, the power calculated and the true operating conditions of the motor.

1. Motor power as computed in Annex C of IS has been multiplied by service factor to make the motor thermally capable for the duty condition. While designing controls, the crane manufacturer should use computed motor-power without service factor for selection of components. The components selected should be able to carry the full load current of the motor power computed without service factor at the specified duty cycle and ambient temperature of operation of the crane.

2. The drive motor should be protected against over heating by means of thermistor trip relay

XXVII.3 Enclosures

All crane motors shall be totally enclosed with or without fan cooling arrangement and shall conform to IS 325, IS 1231 or IS 2223 as appropriate. The enclosures shall suit the specified service conditions. The motor enclosure shall be minimum IP44 for indoor applications and IP 55 for outdoor applications of AC motors. For outdoor applications separate canopy shall be provided for motors.

XXVII.4 Torque rating

The motor shall be capable of producing maximum torque required to produce motion in the most unfavourable loading condition. The pull out torque of the motor or rated voltage and frequency should not be less than 2.0 times the rated torque for the mechanism classes from M1 to M8 as corresponding to computed motor power without service factor.

XXVII.5 Limiting speed

Motors shall be capable of withstanding a maximum speed of 2.5 times rated speed or 2000 rev/min whichever is less.

XXVII.6 Insulation

The motor shall be of Class B insulation or better as classified in the relevant Indian Standard specifications.

XXVII.7 Accessibility

Motors shall be so located that the brushes, gear and terminals are accessible for inspection and maintenance.

XXVII.8 Terminals

Motor leads shall be brought out from the motor frame to terminals in the terminal

box fixed to the motor frame and shall be marked in accordance with IS 4728.

XXVII.9 Slip rings

Slipping motors shall have continuously rated slip rings amply dimensioned to give a long trouble free life.

AC motors may be supplied in IEC frames.

Higher frame size such as above 280 AC motors should have bar wound rotor.

XXVIII. Electric braking (Electro-Dynamic braking)

XXVIII.1 General

Electro-mechanical braking is referred to an automatic electric brake whose action is purely mechanical and the braking effect is nullified electrically by a solenoid, or electro-magnet, or electro-hydraulic release gear. In electric braking the energy is either returned to the line is

dissipated in resistors. In addition to the specific requirements of this code for the brakes and irrespective of the supply current, electrical braking is permissible on all motions of electrically operated cranes.

When electrical braking is used, provision shall be made to limit the current on reversal to a safe value. Effective means shall be provided for stopping the motion in the event of a power failure and in the case of an emergency.

Shunt brakes shall be so connected that it will be applied when the main circuit-breaking device is open irrespective of the position of the controller. Each control circuit shall be electrically interlocked with all associated shunt breaks to prevent power being applied to the motion when the rakes are not energized.

NOTES

1.If a hoist is potentiometer controlled, an auxiliary pole is required on the main circuit-breaker to open the shunt brake and control circuits.

2.In case of hoist motors, either the brakes are released with the energization of motors or the motors are energized.

XXVIII.2 Brake Magnets

The terminals of the brake magnets shall be protected from accidental contact. The connections and windings shall be effectively protected from mechanical damage. Where necessary, magnets shall be provided with an efficient cushioning device. Ratings of brake magnets and thruster brake motor shall be as given in Table 12.

NOTES

1. CDF means 'Cycle Duration Factor'

2. The temperature rise of the brake electro-magnet or thruster at any of the specified duty mentioned above shall not exceed permissible limits for the particular class of insulation used with due consideration of switching current in rush (due to field forcing in case of DC magnet)

3. Maximum duration of cycle shall not exceed 10 min in case of intermittent duty. The brake magnets shall operate at the currents and voltages given in Table 13.

4. Arrangement shall be made, where necessary, to prevent the brake magnet from being energized by the back 'emf'of the motor when the supply has been interrupted.

Table 12 Rating of Brake Electro-Magnets and Thrustor Brake Motor

Type of actuating device	Rating	
	Duty in prevent CDF	permissible switching
DC magnets	20, 40, 60, 100	720
AC magnets	20, 40	120
AC magnets	60, 100	240
AC thruster brake motor	60, 100	720

XXIX Crane Controlling Arrangements

XXIX.1 General

Cranes having alternative control or brake circuit facilities shall be provided with means to prevent operation from more than one facility at any one time.

NOTE: Main circuits are those which carry main motor or magnet current control circuits with brake circuit mechanism are those which are used for control equipment for main motor or magnet.

Table 13 Brake Magnet Operating Currents & Voltages

	Windings	DC magnets	AC magnets
Series	For series resistor Control rated current	Lift at 60 % rated current Hold at 15 %	-- --
	Potentiometer control	Lift at 40 % rated current Hold at 15 % rated current	-- --
Shunt		* Lift at 85% rated voltage * Hold at 50% rated voltage	*Lift at 85% rated voltage * Hold at 50% rated voltage

* This is intended to apply with hot coils corresponding to the duty cycle at rated voltages. The temperature rise of the brake magnet shall not exceed that allowed for the control equipment fitted.

XXIX.2 Controllers

Controllers shall be rated to comply with the relevant Indian Standard specifications. Controllers shall be adequately protected to prevent accidental contacts with the live parts. controllers in OFF position shall open all supply lines of the respective motors. On or adjacent to each control device, there shall be a durable marking identifying the motion controlled and the direction of movement.

XXIX.2.2 Control equipment for AC motors

The selection of contactors shall be made on the basis of S3-40 % rating arrived after applying appropriate service factor to the computed power of the motor. The rating of the control gears such as switches, overloads etc. shall be selected according to the computed

motor power without the service factor of the motion served and not on the motor power computed by the thermal requirements.

The contactors selected shall have the stipulated contact life as may be specified by the user.

XXIX.3 Controller provided in the cabin

XXIX.3.1 General

All control handles and pedals shall be placed in convenient position to allow the driver ample room for operation and permit an unrestricted view of the load. They shall be so disposed that the contacts and terminal arrangements are readily accessible for inspection and maintenance purposes.

XXIX.3.2 Marking Direction of operation of controllers

Where practicable controller handles shall move in the direction of resultant load movement. Each controller shall be marked in a permanent manner to show the motion controlled and direction of movement. For vertical handle operating hoist controllers, movement towards operator shall indicate hoisting and movement away from operator shall indicate lowering.

XXIX.3.3 Notching

The notching for the controller handle in the OFF position shall be more positive than the notching in other positions. The handle may be provided with alock, latch, dead man or spring return feature. The control lever shall be provided with stops and/or catches to ensure safety and facility of operation. A controller drum fitted with a star wheel shall be regarded as complying with the requirement.

XXIX.3.4 Master controller

master controller operated cranes shall be provided with automatic control of acceleration. Accelerating torque/current peak shall be limited during controller handle movement from one notch to the other with due consideration to the pullout torque of the motor and number of rotor accelerating contactors shall be selected accordingly. For master control operated cranes the control voltage preferably 110 AC and shall not exceed 240 V for AC or DC supply.

XXIX.4 Pendant controllers

XXIX.4.1 General

Cranes with pendant controls shall not have long travel speed in excess of 40 m/min. Pendant control may either descent from the independently traveling trolley.

XXIX.4.2 Pendant switches

The pendant switches shall be capable of withstanding rough handling without being damaged and the cover shall be effectively secured. If control is from the floor, the electrical control circuit to the pendant shall be energized at not more than 110 V DC or AC supply.

XXIX.4.3 Pendant control

On all pendant controlled cranes means shall be provided to prevent inadvertent operation from the floor while maintenance work is being carried out on the crane. An isolator fitted on the crane bridge, which cannot be operated from the floor will comply with this requirement.

XXXIX.4.4 Pendant control station

If the control is by push buttons or switches, they shall automatically return to the OFF position immediately after they are released. One lockable type push button shall be provided to switch off control power even the crane is not in use and if other means of switching off is not available.

XXIX.4.5 Suspension of Pendant switch

The weight of the pendant shall be supported independent of the electric cables by means of chain or wire rope. If the pendant enclosure is of metal it shall be effectively earthed. A chain or hook does not provide effective earth connection.

XXIX.5 Remote Control System
XXIX.5.1 Main features of the radio control system consist of :

a) A portable transmitter

b) An antenna and receiver on the bridge, and

c) An intermediate relay panel on the bridge to amplify the signals for the crane contactors.

XXIX.5.2 Radio controls should be designed so that if the control signal for any crane motion becomes ineffective, that crane motion will stop, and conversely signals received from any source other than the transmitter will not result in operation of any motion of the crane. The crane must not take off on its own or respond to or generate false commands. In case electricity failure occurs, the crane must stop.

A key switch or equivalent security device on the transmitter that can be used to prevent unauthorized use of the transmitter.

The sending of a continuous or continuously repeating secure signal when transmitter is in use, which the crane receiver can identify. A secure signal includes at least three characteristics separately recognizable by the receiver.

An emergency stop device shall be used for emergency stop.

A carrying harness, belt, shoulder strap or lanyard on the transmitter.

XXIX.5.3 The manufacturers should supply motion switches with different shaped knobs so that the motion can be selected by feel and the operator's vision remain on the load. Modular construction shall be preferable for easy replacement.

XXIX.5.4 Typical frequencies used for radio controls are in between 450-470 MH for which licence is required. The recommended crane controls for operating are of maximum 250 meter range.

Radio crane control transmitter lever arrangement are of four motions, namely, are given below.

Bridge	Trolley	Main hoist	Aux. hoist
X	Y	Down	Down
O	O	O	O
W	Z	Up	Up

Radio crane control transmitter lever arrangement are of three motions, namely, are given below :

Hoist	Bridge	Trolley
X	X	Down
O	O	O
W	Z	Up

NOTES

1.Markings on the crane visible from the floor, shall indicate the direction of bridge and trolley travel corresponding to the W, X, Y and Z designations on transmitter.

2.The maximum working range of radio control limit shall be limited to 40 - 50 mm from the transmitter. This limitation reduces the likelihood of an accident caused by the crane operating beyond the operator's visibility.

3.It is recommended that a device is fitted to the crane to give warning that the crane is under non-conducive control.

4.Incorporate a limited range feature, present by means not available to the operator so that the crane will stop when the extent of that range is reached.

5.If more than one crane are provided with this type of controls, only the intended crane and its motion is operated at one time. The transmitter shall be constructed so that it is capable of withstanding rough handling.

XXIX.6 Control Circuits

If the main s supply is AC and the control circuits are supplied at reduced voltage, the supply to these circuits shall be from the secondary winding of an isolating transformer or an isolating transformer and rectifier. The transformer frame and one pole of this supply shall be earthed and the contactor and relay coils shall be connected to this pole. An earthed screen shall be provided between the primary and secondary winding. The primary winding and unearthed pole of secondary winding of the transformer shall be protected by fuse in line connection. Effective means shall be provided to prevent mal-operation owing to short circuits or earth faults.

XXIX.7 Rectifiers

On AC cranes, if DC supply is required, rectifiers shall be provided for supplying the control circuit, brakes and magnets. These rectifier units shall be of adequate capacity to supply the full DC loads required continuously. They shall be of suitable construction and mounting to withstand heat, dust, shock and vibration. Silicon type rectifier units shall be preferred. Adequate fuse protection shall be provided for the rectifiers. Rectifiers/thyristors used for magnets shall be protected against switch surges.

XXIX.8 Braking controls

When an electro-mechanical brake is used as an emergency or parking brake or when such an emergency or parking brake is used with hand or foot operated travel service brakes, the brake actuating device shall remain in the circuit when the main circuit breaker is closed. The brake shall apply automatically when the power supply fails or when the circuit breaker is opened or on operating an emergency stop push button or switch; but not when the controller handle is brought to the OFF position.

The brake shall lift off when voltage at the coils is a minimum of 85% of rated voltage. Provision shall be made for emergency application of this brake by means of the emergency stop push button or switch.

In the arrangement of connections to the hoisting motion brake coils, means shall be provided to ensure that when associated drive motors are de-energized, the stored electrical energy in these motors will not delay the application of the brake.

XXIX.9 Acceleration control

Automatic control of acceleration shall be provided for all crane motions, unless for any motion another control system is specified. The hoist motion circuits shall enable any load to be lowered with safety and the hoist motors shall remain under effective control with the controller in all positions. While calculating the number of rotor contactors, peak accelerating/decelerating torques and pull out torque of the motor should be taken into account.

For creep lowering speed on hoisting motion, relatively flat speed control shall be provided.

XXIX.10 Markings on the crane

When the control devices are other than in a fixed position relative to the crane, the designation of horizontal directions marked on the control device shall be marked on the crane so that it is clearly
visible to the driver.

XXX Protective Equipment

XXX.1 General

Supply located efficient means shall be provided to protect every part of a system from excess current and voltage to prevent danger or damage. Enclosures having minimum degree of protection IP 44 shall be provided for all electrical equipments except for motors and resistors

XXX.2 Electrical protective device

XXX.2.1 General

If electrically operated contactor equipment is used for control of all crane motions, the protective equipment shall be in accordance either with Scheme A, in which each motion has separate protection; or with Scheme B, in which an overload of any motion trips off the crane supply. If drum controllers or master controllers are used for the control of all motions, the protective equipment shall comply with Scheme B. Also it is more often required that in master controller operated crane, overload of any motion should not trip the complete crane circuit, but should trip the individual circuit.

In general, overload protection shall be of electro-magnetic type with time delay. Thermal overload relays in conjunction with high rupturing capacity fuses or manual reset type overload relays may be provided if agreed by the purchaser.

Where a motion is ward-Leonard controlled, provisions shall be made for :

a) protection in case of motor field failure

b) protection against the motor creeping when the controller is in the "off" position, and

c) tripping of the generator field circuit with suppression of generator voltages instantaneously when there is an over current of 250 percent in the generator-motor loop; or after a time-lag when there is a sustained over current of lower value.

Operation of any of the above protective devices shall automatically apply the electro-mechanical brakes on the relevant motion. If other systems of control or mixed systems are specified, the protective equipment shall be in accordance with the recommendations of the control gear manufacturer. An indelible circuit diagram of the protective equipment shall be provided in the electrical equipment compartment.

XXX.2.2 Protective device common to all motions

As minimum equipments of protection, electro- magnetically operated contactors or manually operated circuit breakers fitted with no volt release, capable of cutting off the power supply to the motion drives with under voltage protection shall be provided. Adequate protection against short circuit shall be provided at each of the isolator positions. The circuit breaker of the main contactor shall be rated to carry at least the combined full load currents of motors for any two motions having largest powers and auxiliary loads such as magnet, etc.more than two motions may be operated simultaneously, circuit breaker / main contactor shall be rated to suit the requirement. In appropriate case, high rupturing capacity fuse may be provided.

The circuit-breaker shall incorporate thermal and electro-magnetic overload protection device for protection against sustained overload and short circuit condition. If adequate protection against short circuit is to be provided at each isolating positions, there will be either HRC fuses or MCCB/ACB in each isolating position. As HRC fuses may lead single phasing , only MCCB should be provided in each isolating position. The circuit breaker or main line contactor should not be rated to carry magnet full load current as magnet supply is taken before the circuit breaker / main line contactor. The breaker shall have rupturing capacity to withstand and clear fault current of the system. If specified a suitable control

circuit may be provided for this circuit-breaker to prevent it from being closed when the main contactor of a particular motion has failed to open, although the corresponding controller has been brought to its 'Zero' position.

XXX.2.3 Scheme A - Protective Device for individual Motions

The provision of overload protection with adjustable inverse time lag overload release shall be under-voltage release and with overload. The minimum provision of overload protection shall be such that all supply lines except one to each motion shall be provided with adjustable inverse time-lag overload releases. These shall be connected as close as possible to the contactors they control and shall be set to trip the circuit of the motion controlled when carrying 200% of the full load current of the motor, after a time-lag of not more than 10s.

It shall not be possible to reinstate the current supply to the contactor closing coils of a motion until the master controller for that motion is returned back to the 'off' position.

XXX.2.4 AC Instantaneous release single pole over load; Protective Device for individual motions

Any motor having its power less than one-third that of the largest motor and served by the same common overload release, shall be protected by a separate overload release. However, normally instantaneous release of overload relays are not used for individual motion and circuit breaker is tripped by its own overload. In crane with circuit breaker overload protection is provided by circuit breaker, in cranes with line contactor one triple pole magnetic overload relay rated for total crane power may be provided to trip the main contactor.

Adjustable overload releases shall be provided to trip the main contactors or circuit-breakers and shall be connected as close to them as possible. The minimum provision for over current protection shall be as given below :

a) One instantaneous release in a common line feeding all motions set to trip the main contactors or circuit breakers instantaneously when the current rises to 250 % of the value specified above ; and

b) One inverse time-lag release in each other line feeding each motion, set to trip the respective motion when carrying 200 % of the full load current of the line, after a time-lag of approximately 10s.

It shall not be possible to reinstate the current supply to the common main contactor closing coils, or complete the under voltage circuit of the circuit breakers until the master controllers for all motions are returned to the 'off' position.

XXX.3 The number of overload devices and their position shall normally be in accordance with the arrangements shown in Table 14. If specified by the purchaser, other arrangements giving protection not less than any of these shall be considered as complying with the specification.

Table 14 Normal Requirements for Number of Protective Devices for circuit

DC Supply		3- Phase AC Supply
No Line Earthed	One Line Earthed	
2 Per motion in separate lines	1 per motion connected in the non - earthed line	3 per motion in separate lines

XXX.4 Contactors

Reversing contactors shall be interlocked, preferably mechanically as well as electrically so that only one directional contactor can be in the closed position.

XXX.5 Control switch fuse

Operating coil circuit of the main contactor or control contactor in case of cranes with circuit breaker. A double pole control switch fuse shall be connected in the operating coil circuit of the contactor. Maintenance circuit-breaker as alternative to control switch fuse may also be used.

XXX.6 Emergency switches

A mushroom head push button or a prominent switch for emergency stop shall be provided at each control facility to switch 'off' the total crane supply or to de-energize the main contactor common to all the motion drives. When any circuit-breaking device is open no main pole on the normally dead side shall be made alive by a parallel circuit in emergency.

The emergency switch shall be so located as to be readily available for prompt use by the operator in case of emergency. When the crane span is larger than 20 m, the number of emergency stops shall be more than one. A reset button shall be provided. The emergency stop push-buttons or switches shall be connected in the operating coil circuit in the case of a contactor and in the under voltage release circuit in the case of a circuit breaker.

XXX.7 Off-position Interlocking

Electrical interlocking shall be provided to prevent inadvertent starting of the motions, in the case when power is lost, without the controller being brought to the 'off' position on restoration of the supply.

XXX.8 Pilot Lamp

A red pilot lamp shall be connected to indicate that the crane is ready for operations and it shall be so located that it is visible to the operator. The pilot lamp shall be connected so that it indicates whether the control supply is ON or OFF or the contactor is CLOSED or OPEN.

XXX.9 Thyristor control Main features

a) The thyristors shall be protected by fast acting semiconductor fuses having 12 x t considerably lower than that of the thyristors. These fuses shall be continuously monitored

so that blowing of any fuse shall result in tripping of the power circuits.

b) The thyristor shall be suitable to carry at least 200% of the drive motor current rated S3-40 %. The PIV of the thyristor shall be 2.5 times the system peak voltage appearing across the thyristors. The factor 2.5 has been selected taking into account the line voltage variations.

c) Each thyristor shall be protected by RC snubber circuits so as to absorb the surges generated out of external line surges in consultation with the user.

d) The drive system shall be protected against overload by means of thermal overload or oil dash pot of magnetic overload type with inverse characteristics having adjustable setting range. It shall also be protected against over current by mans of instantaneous acting over current relays having a setting range of 200 to 400 % of the drive rated current. Solid state overload protection may be used subject to thermal overload protection to use instead of magnetic overload relays as the thermal overloads have a rest time which would prevent the drive from restarting back immediately.

e) Switching-off of reversing contactors shall be done at near zero current. This is to be done by ensuring that the stop/tripping command first inhibits the thyristor controller and then switches "off" the reversing contactors. This requirement will not be applicable if the reversing is through thyristors.

f) In the case of overloading or the single phasing of the synchronizing supply, the circuits shall be tripped immediately.

g) Whenever or stator reversal (in case of the AC drive) is to be done through the reversing contactors, the drive shall be protected against the free fall conditions at the time of switching on and reversals by having the preferred switching state of the reversing contactor. The drive controller shall have suitable provisions for preventing load drifts at the time of start and stop.

h) For achieving smooth acceleration of the drive mechanism suitable ramp generator circuit shall be available with the controller.

j) Wherever necessary, suitable duration would be considered for AC/DC motors in consultation with the thyristor controller manufacturer and the motor manufacturer.

k) The control circuits shall be so designed that the brakes are applied at around the zero speed.

m) Test points shall be available in the cards

n) In case of wide deviation of the speed in actual value from the set value, the circuit shall trip the mechanism immediately. During acceleration or deceleration period such tripping shall be prevented by adjustable time setting.

p) Thyristor control shall be suitable for operation at vibration levels and environments encountered in the crane operation.

q) If specially required by the purchaser, the drive motor shall be protected against overheating by means of thermistors embedded in the motor winding. Matching thermistor for trip relay shall be provided by the control panel. The embedded thermistors a best for

preventing overloads and subsequent overheating of the motor as these thermistors give the correct thermal image of the motor irrespective of the current carried.

r) Wherever AC phase controllers are to be parallel for load sharing, the converter outputs shall be parallel only at the load end and not at the converter end.

XXX.11 Special protection for Direct Current Drive System

a) To minimise excessive rate of rise of armature current and radio frequency interference, commutating chokes with sufficient inductance shall be provided on the AC side so that PU (inductive drop) across the choke lies between 2 to 4%. Where isolating transformer is used, commutating chokes are not necessary.

b) To prevent excessive wear and tear of the commutators, the ripple content of the DC output shall be minimized by providing smothering chokes of sufficient inductance depending upon motor design.

c) In case of the four quadrant drives, to protect against inverter commutation failure during regenerating mode, branch thyristor fuses shall be used. However, where it is not possible to use branch thyristor fuses, there shall be at least one fast acting semi-conductor fuse on the DC side of the converter in addition to the semi-conductor fuses on the AC side.

d) While switching on the system, the following sequence shall be adhered to :

i) Synchronising supply is switched "ON"

ii) Field circuits are established, and

iii) AC / DC contactors are switched "ON"

e) The drive shall be protected against field failure with suitable circuits

f) The field current shall be reduced to a safe value during the crane idling time to reduce the heating of the motor. The normal field current shall resume at the start of the drive operation.

XXX.12 Main Feature of Built-in Crane weighing System (Load Cell)

a) The load cell shall be of compression type and IP 68 protection

b) The power supply shall be 230 V, AC or 110 V AC 50 Hz single phase

c) The load cell shall be placed in such a way that the load which is inert on the equalising pulley/bar is transferred to this load cell by a pivot assembly

d) The built-in crane weighing system should have local indicator, processor based type, LED display, IP 55 protection, shall be located on the control cabin of the crane.

e) The built-in crane weighing system should have remote indicator, LED display type, minimum visibility range of 50 m, shall be located on the crane girder.

f) The resolution shall be in the order of 5 kg.

g) The system shall have the provision of tripping the circuit in case of overloading the cranes and should serve on an additional overload safety device

XXXI ISOLATION

XXXI.1 General

Means shall be provided on the crane for isolating the crane from the power supply close to the connector or terminal box in the case flexible cables are used. These shall take the form of isolating devices fed in parallel as follows :

a) for motion drives,

b) for auxiliary circuits, and

c) for the lifting magnet, if fitted

XXXI.2 Isolating Device for Motion Drives

The isolating device for the motion drives shall be capable of interrupting the stall current of the largest electric motor fitted to the crane or combined full load currents of the motors of any two motions of the crane using the largest power kw)working together whichever is more and working together with auxiliary loads. Main switches used for isolating shall comply with the relevant Indian Standards. The isolating switch shall be unfused, unless high breaking capacity fuse protection is specified.

XXXI.3 Isolating switches and Isolators

XXXI.3.1 Cabin Operated Cranes

For all cabin operated cranes a main isolating switch shall be fitted in the cabin or adjacent to it capable of cutting off the supply for all power driven and associated equipment on the crane, except auxiliary connections such as warning lights, lighting, fan and heating circuits, air conditioners, magnet circuits and communication circuits.

When the operator's cabin is fitted to the trolley and moves in relation to the main crane structure, an isolating switch outside the crane cabin shall be provided in addition to the isolating switch in the operator's cabin.

XXXI.3.2 Pendant Controlled Cranes

For pendant controlled cranes, an isolating switch shall be fitted.

XXXI.4 Isolators for Auxiliary Circuits

All auxiliary connections, when required, shall be supplied from the live side of the main isolating switch and shall be controlled by separate isolating switches with cartridge protection. If the supply voltage exceed 240 volts and if lamps are operated in series, double pole isolating switches shall be provided.

XXXI.5 Interlocking

If the main isolating switch is combined with the crane protective panel, it shall be mechanically interlocked with the door giving access to the panel and the incoming terminals shall be screened to prevent accidental contact when the door is open. When not so combined, a pair of pilot lamps or other device in duplicate with a red plate shall be provided to the covers of the protective gear, other panels and controllers not fitted with interlocking isolators. Access to the enclosures containing electrical equipments shall require use of a key or a tool to open them.

XXXI.6 Isolating switches for Down-shop conductors

Isolating switches for the down-shop conductors shall be provided by the purchaser at a suitable and accessible locations. The main and additional isolating switches should be so situated that maintenance work or functional testing can be carried out without danger.

XXXI.7 LIFTING MAGNET AND RELATED EQUIPMENTS

XXXI.7.1 General

If required by the purchaser, the crane shall be fitted or provision shall be made to permit in the future fitting of lifting magnets, magnet control and protective gear.

XXXI.8 Magnet

The type and size of magnet shall be decided based on the details given by the purchaser. Each magnet will be water tight and shall be provided with a water tight terminal box having the under mentioned features, however rectangular magnets are normally of fabricated construction type also can be used as follows :

a) integral construction with magnet casing

b) a gland through which the magnet load is brought to the magnet terminals

c) a cover which shall be easily removable without interfacing with the magnet lead inlet

d) adequate thickness of box and cover, and

e) non-linear type discharge resistor of adequate rating and the rectangular magnets are fabricated constructions and nice fabricated type of magnets.

XXXI.9 Magnet Lead and Cable

The magnet lead and cable shall be flexible three core cables. If specified by the purchaser, the magnet lead shall be protected by rubber hose complying with the relevant Indian Standard. The magnet lead shall be so arranged that it does not become unduly slack or taut during normal operation of the crane. It should be so located that magnet cable does not foul with the rope. The use of sheaves and rollers for the cable should be avoided as far as possible. The magnet cable shall be rigidly attached to the bottom block by a suitable cable clamp at a point above magnet coupling.

XXXI.10 Magnet couplings

The type of magnet coupling shall be as agreed between the purchaser and the crane supplier. The coupling shall comply with the following requirements:

a) The coupling shall be of rugged construction

b) At the moment of breaking, the contacts shall be enclosed by insulating material and earth connection shall break last

c) Provisions shall be made to fasten the coupling in the closed position

d) The socket shall be connected to the supply and plug to the magnet or magnet lead

XXXI.11 Cable Drum

The magnet cable drum shall be as follows :

a) arranged so that magnet cable does not foul with the hoisting ropes

b) such that the cable will become neither unduly taut, nor slack enough to touch the hoist ropes or get entangled, and

c) capable of accommodating and paying out the length of cable necessary for the magnet to reach its lowest position.

Cable drum when attached to the hoist drive, a disengagement device shall be provided. Where power is fed to the magnet by brush and slip ring arrangement on the magnet cable drum, two brushes per slip ring shall be provided and the rings shall have adequate clearance. The slip ring insulation shall be of non tracking material and the assembly shall be enclosed by an easily removable cover, oil-proof for indoor cranes and weather proof for outdoor cranes. A spare slip ring complete with brush gear arrangements shall be provided if required by the purchaser.

XXXI.12 Magnet Control and Protective Equipment

The magnet shall be controlled either by direct-on-line control or potentiometer control as required by the purchaser. In both methods of control the magnet shall be demagnetized by current reversal.

In direct-on-line control, the magnet shall be energized by switching t across full mains voltage and discharge resistance shall be connected on switching "OFF"

The control shall be affected by means of a master controller and magnetic contactor panel.

XXXI.13 Battery backup system

If required by the purchaser necessary and adequate battery back up system shall be provided by the supplier. The rechargeable battery shall keep the magnet energized till the time the lifted load is brought to a safe location, the case of power failure.

XXXII Resistors

XXXII.1 General

Resistors shall be adequately protected to prevent accidental contact with live parts. The elements shall be protected against corrosion.

XXXII.2 RATING

Resistors shall be rated such that the temperature does not exceed the limits specified in the relevant Indian Standards specification, during the operation of the crane under service condition. The resistance and current capacity of the resistors shall be computed according to the actual torque requirements of the motion served and not on the motor size which may be set by thermal requirements.

The effect of using plugging as a service brake shall be taken into account in determining the size of resistors. Resistors shall be rated according to the service conditions and the mechanical class of the crane and shall preferably be intermittent and short time rated. The rating of the resistors shall not be less than that given in the Table 15

NOTE: For definition of different intermittent rating, see Annex E

Table 15 Rating of Resistors

Mechanism Class	Short Rating for Time Rated Resistors, Min
M1, M2	2
M3, M4, M5	5
M6, M7	10
M7, M8	To suit the service Condition

XXXII.3 Fittings

Resistors shall be enclosed in the well ventilated housings and wherever necessary be fitted with suitable covers. They shall be mounted outside the main contactor compartment. Resistors shall be mounted on steel frames to withstand forces imposed by the crane under service condition. They will be arranged in such a way that boxes can be easily replaced.

The connections to the resistor terminals should be accessible and adjustable. Resistor assemblies shall not impede the maintenance of the long travel drives or access to any part on the crane.

Resistors assemblies for each motion shall be stacked separately for the facility of inspection maintenance and safety.

XXXII.4 Degree of Protection

Minimum degree of protection for the resistors shall be IP 11 or as specified by the purchaser.

XXXIII. LIMIT SWITCHES

The limit switches shall be of self-resetting type with in a reasonable distance travel in the opposite direction. In the case of changeover (memory) type limit switches resetting is achieved by striker moving in the opposite direction.

Snap action limit switches when actuated shall stop the motor and shall apply the brakes or shall initiate dynamic braking if provided. The actuation of the limit switch shall trip the main incoming circuit breaker/contactor and shall operate an audio/or visual warning signal if required by the purchaser.

The manufacturer should fit one or more devices to the bridge of the crane to give warning of the approach to the danger or another crane. However, the purchaser can specify about the type of devices required for his crane so ordered. Devices using infra red lights, sound waves or limit. proximity switches may be used for this purpose. Limit switches shall be so arranged that they can be readily tested.

In the case where abnormally high lifts are required arrangements shall be made by providing additional limit switches and by passing buttons as required by the purchaser. Fast or slow speeds may be provided for lifting heights as required by the purchaser.

Cams for strikers, when used for actuating limit switches, shall not damage the limit switches on over travel due to impact or inertia.

XXXIV. CABLES AND CONDUCTORS :

XXXIV.1. General

Cables used for crane wiring shall comply with relevant IS specification. Unless otherwise agreed, only copper cabals shall be used for control wiring. Single strand cables shall not be used where cable cross sectional area is more than 6 mm^2

XXXIV.2. Minimum size.

Conductors for power wiring/control circuits to electric motors shall have a section area not less than the values given below of copper or equivalent material.

a) (2.5 mm^2 for Power) and (1.5mm^2 for control wire) should be up to M5 class
b) (4.0mm^2 for Power) and (2.5 mm^2 for control wire) should above M6 class

XXXV.3 Protection

All cables shall be adequately protected against mechanical damages as given below :

a) by running in conducts complying with relevant Indian Standards, trucking on trays, or
b) by being clipped to the crane structure in a position where they are protected from mechanical damage, or
c) by being armoured construction

If cables are drawn into a steel tray, the tube shall be medium gauge welded or solid drawn or screw jointed. For outdoor cranes except where flexible unarmoured cables are essential, cables shall be either armoured or enclosed throughout their length in galvanized trucking or

conduit. Taped and braided varnished cambric insulated cables shall not be used for outdoor cranes.

XXXI.4 Current rating

Rating of the cable, in the circuit related to mechanism Group 8, shall be not greater than the appropriate values given in the relevant Indian Standard Specifications for continuous duty giving due considerations to ambient temperature, type of excess current, protection, grouping and disposition of cables and voltage drop. Cables in circuit related to mechanism group below M8 may be rated higher in accordance with Table 16.

XXXIV. 5 Insulation

The cable and wiring system for each motion shall be independent and common return shall be avoided. Main cables and controlled wiring shall be effectively separated. Cables shall be adequately secured to the main structure of the crane having due regard for the weight of the cable and the possibility of vibration. Cable runs shall not be installed in a place where they will impede the crane driver's view or hamper the movement of persons on the crane. The cables shall be placed so that they are easily accessible. Due consideration shall be given during for cable runs and to avoid cable runs in locations mechanical damage or high temperatures are likely to be experienced. The segregation of power and control cables shall be made as far as possible depending upon the space available on the crane and keeping or maintenance point of view.

Table 16 Operative Rating Cables

Mechanism Class	Stator Circuit Rating Multiplied By	Rotor and Resistor Rating Multiplied By
M1, M2	2.0	2.5
M3, M4, M5	1.7	2.0
M6, M7	1.4	1.5
M8	1.1	1.1

Where there is incidence of direct radiation of heat, the cables shall be protected by metallic shield. Where mineral insulated metal cables are subjected to the effects of high transient voltage they shall be suitably protected by the use of surge limiting devices. Cables remaining alive, when main isolator is opened, shall be separately installed and adequately protected. Adequate precaution shall be taken to prevent the ingress or collection of water or oil in any part of a conduit or trucking system.

XXXIV.6 Termination

Where trucking is used it shall extend into the electrical compartment or enclosed units. It shall be terminated as close as practicable to motors, collector gears and controllers. Junction boxes shall be rigidly fixed to the crane structure close to the end of the trucking. Conducting systems shall be continuous to switch boxes and conduit outlets. Cable tails shall be adequately insulated and mechanically protected.

XXXV. AUXILIARY REQUIREMENTS

XXXV.1 Lighting on the Crane

Necessary lighting arrangements for approaches and for carrying out maintenance work without danger shall be provided by the crane manufacturer in consultation with the purchaser. The nominal voltage of lighting circuits shall not exceed 250 V.

If hand lamp is provided it shall not be connected to a circuit exceeding 250 V DC or 25 V AC supply. In the case of an AC circuit hand lamp shall be fed through a double wound isolating transformer with some part of the secondary winding earthed. The primary winding of the transformer shall be controlled by a double pole switch. Fuses shall be provided in each pole of the primary circuit and one pole of each of the secondary circuits.

XXXV.2. Cab Lighting :

The cab and the panel room shall be provided with adequate lighting

XXXV.3 Under the Bridge Lighting

Under bridge lighting if required by the purchaser shall be mounted on shock absorbers and so installed that they can be serviced easily.

XXXV.4 Other Provisions in the Cab

As required by the purchaser fans, air-conditioners or cab heating arrangements shall be provided by the crane manufacturer.

XXXV.5 Crane warning signals

If required by the purchaser, the crane shall be equipped with warning lights on both sides of the crane and/or sound signals to indicate approach of the crane or hook. Each warning light fitting shall contain two electric visible to the concern persons.

XXXVI. CONDUCTORS AND CURRENT COLLECTORS

XXXVI.1 General

The type of current collecting system for long travel and cross travel motion shall be provided as required by the purchaser. Bare conductors used for the purpose of picking up current shall be placed out of reach or protected to prevent accidental contact by persons operating, maintaining or inspecting the crane. No bare conductors should be placed in the inner middle of grinder all types of conductors system should be accessible for maintenance and replacement. The protection may be in the form of local guards fitted on the crane.

XXXVI.2 Bare Copper Wires

Bare copper wires when used as conductors shall comply with IS 282. Wires smaller than 2.5 mm^2 of equivalent copper area shall not be used. Intermediate supporting insulators for the copper wires shall prevent wires leaving them under any condition. Adequate tensioning

devices shall be installed at the wire ends and there shall be no possibility of adjacent wires coming into contact.

XXXVI.3 Trailing Cable Arrangement

In the trailing cable arrangement of the conductor shall be insulated flexible single or multiple core cables as specified in 19 with permanent termination on the fixed part and moving part. The flexible trailing cables shall have sufficient length and shall be supported on trolley with clamps. The trolley shall run freely on a guide without undue stresses or wear on suspended cables and cable trolleys should have four wheels fitted with antifriction bearings.

XXXVI.4 Rating

Unless otherwise specified the maximum current density shall not exceed 0.42 A/mm² for copper sections. The gap between the current collector and adjacent live or earth part shall not be less than 50 mm.

XXXVI. 5 Down-Shop Lead Arrangement (Long Travel Current Collecting System)

XXXVI.5.1 General

Down shop lead arrangement using copper, aluminium or steel sections with or without shrouding or by using flexible trailing cable arrangement may be used. Use of shrouded conductors, where possible is recommended.

XXXVI.5.2 Condcutors

Current collecting system shall be provided either by the purchaser or by the crane manufacturer as agreed by them.

Cranes operating on bare conductors shall be equipped with adequate guards to prevent ropes or suspended load coming in contact with the live conductors due to swing of the hook block. Down-shop conductors also shall be screened to prevent contact while handling long lengths of conducting materials from floor.

XXXVI.5.3 Current Collectors

Unless otherwise agreed to, all collector assembly shall be supplied by the crane manufacturer. The purchaser shall furnish relevant details depending upon the manufacturers scope of work. Collector rollers or shoes shall be so designed as to avoid sparking an shall be easily replaceable. Collector assembly shall be mounted on a rigid structure on the crane bridge. Necessary safe convenient access shall be provided for maintenance or replacement of the collectors.

XXXVI.6 Cross Travel Current Collecting System

XXXVI.6.1 General

Cross travel current collecting system shall be with bare conductors or with shrouded conductors or with trailing cable arrangement. The collection system shall be provided by the manufacturer.

XXXVI.6.2 Cross travel conductors for the main crab shall be mounted on the main bridge platform and not inside the main girders. Conductors for auxiliary crabs shall be mounted suitably above the level of auxiliary crane rails. Cross travel conductors shall be arranged so that they are all accessible for maintenance from at least one side along the whole length. bare conductors mounted on the bridge adjacent to a walk way along the bridge shall be completely screened from the walkway.

XXXVI.6.3 Collector Assembly

Collector assembly shall be rigidly mounted on the crab and shall be provided with reasonable accessibility to all parts for maintenance purpose.

XXVII. EARTHING

XXXVII.1 General

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 with Indian Electricity Rules (See IS 3043). A flexible metallic tube or duct may not form an effective earth connection. The crane wheels shall not be used as means of earthing.

Where the crane is connected to the supply by flexible cord or flexible cable, the crane shall be connected to earth by means of a separate earthing conductor enclosed with the current conductors.

Traveling cranes connected to the supply through collectors shall be effectively earthed through a fourth lead or through a set of collectors sliding on the gantry rail with reference to IS 3043.

The purchaser shall arrange for the earthing of the gantry and/or the long travel earth conductor.

XXXVII.2. Control Circuit Earthing

One end of the secondary winding of control circuit transformer shall be earthed. One end of the coil of all relays and contactors shall be connected to earth side on the control circuit supply and this connection shall not be interrupted by any fuse or contact.

In the case of DC control circuits one pole of the rectified shall be earthed.

XXXVII.3. Magnet Earthing

The magnet frame shall be bonded to the crab by the earth connection via the magnet lead, the magnet coupling, the magnet cable and an extra slip-ring on the cable drum.

XXXVIII. ELECTRICAL EQUIPMENTS LOCATED ON THE CRANE BRIDGE

XXXVIII.1 General

Electrical equipments mounted on the crane bridge platform shall be enclosed in suitable enclosure with provision for easy access to the parts inside. The units shall not impede the maintenance of the long travel drives. The control panels or units shall be so spaced that

efficient maintenance is possible. They shall withstand the mechanical forces imposed by the crane under service conditions. For cranes working in open yard, electrical equipments shall be weather-proof construction for the duty. Control panels and other electrical equipment shall be so located that there is no chance for oil or grease falling on them. The thorough fare between any portion of the crane and the exit platform shall not be impeded by any control unit. However, also refer the below given Table 17 for information may be suitably used for the enclosures where discussed.

XXXVIII.2 Identification of Circuits

All switches, fuses, panels, controllers, resistors connectors and other electrical elements of controller panels shall be adequately labeled or marked by furnishing functional nomenclature to facilitate identification of the circuit. All main and control wires and conductors shall be ferruled and numbered at both ends as per drawing for quick identification. All equipment terminals shall be numbered and tagged.

Table 17 Information for Enclosures

Equipment	In-door	Out-door
Control panel	IP 54 (with double door)	IP 55 (with double door)
Limit switches	IP 54	IP 55
Resistances	IP 11	IP 33
Motor	IP 54 (without cover)	IP 55 (with cover)

XXXIX. DRAWINGS:

A wiring diagram of the crane shall be supplied by the manufacturer. The diagram shall give the rating of each motors, the cable sizes and such other information which will facilitate inspection and maintenance of the crane. All electrical elements shall be designated by functional nomenclature and numbered for identification. All main and control wires and terminals shall be numbered to facilitate wiring diagram shall also be supplied for contactor controlled cranes along with the list of parts used. In addition to the drawings the following drawings and documents may also be provided as given below :

a) External termination drawings and cable schedule, and
b) GA drawings of all electrical items.

DETAILS OF THE CRANE TO BE FURNISHED BY THE MANUFACTURER

1. IMPORTANT DETAILS

a) Total weight of the crane (in MT) .....

b) Weight of the girder .....

c) Weight of the girder and platform .....

d) Weight of the end carriage with wheels .....

e) Weight of the trolley .....

f) Trolley span .....

g) Weight of the cabin .....

h) Type of festooned cable system .....

j) Weight of legs .....

k) Wt. of LT mechanism with frame .....

2. Detailed calculation for motors

Main Hoist .....

Aux. Hoist .....

Cross Travel .....

Long Travel .....

3. Detailed calculation for Brakes

Main Hoist .....

Aux. Hoist .....

Cross Travel .....

Long Travel .....

4. General arrangement drawings of the crane and Trolley

5. ROPE DRUM DETAILS

a) Material .....

b) Diameter .....

c) Length .....

d) Flange / flangeless .....

6. Rope Details		**Main Hoist**	**Aux Hoist**
a) Rope construction	/ Main core	.....	.....
b) Tensile strength		.....	.....
c) Diameter of the rope		.....	.....
d) Length of the rope		.....	.....
e) No. of falls		.....	.....

7. Sheave Details

	Main Hoist	**Aux Hoist**
a) Material	.....	.....
b) Diameter of the sheaves (Main)	.....	.....
c) Diameter of the sheaves (Equalizer)	.....	.....
d) Type of guards provided	.....	.....

8. Coupling Details (Between Motor and Gear box)

	Main Hoist	**Aux Hoist**	**LT**	**CT**
a) Type of coupling	.....	.....	.....	.....
b) Torque rating	.....	.....	.....	.....
c) Size	.....	.....	.....	.....

9. Coupling Details (Between Gear box and Rope Drum)

	Main Hoist	**Aux Hoist**
a) Type of coupling	.....	.....
b) Torque rating	.....	.....
c) Size	.....	.....

10. Coupling Details (Between Gear Box and Wheels)

	L.T	C.T
a) Type of coupling	.....	.....
b) Torque rating	.....	.....
c) Size	.....	.....

11. Gear Box Details

	M.H	A.H	C.T	L.T
a) Type of mounting (Horizontal/Vertical)	.....	.....	.....	.....
b) Classification	.....	.....	.....	.....
c) Total no. of reduction	.....	.....	.....	.....
d) Reduction ratio	.....	.....	.....	.....
e) Type of lubrication (grease/splash/pump/ lubrication)	.....	.....	.....	.....
f) Hardness (BHN) Gears/Pinion	.....	.....	.....	.....
g) Materials-Gears/Pinion	.....	.....	.....	.....
h) Casting/Fabricated (gear box casing)	.....	.....	.....	.....
k) Type & size of bearings in each size	.....	.....	.....	.....
m) Kw rating	.....	.....	.....	.....

12. Type of Drive Arrangement (Vertical / Horizontal)

M.H	A.H	C.T	L.T

13.Wheels Details

	Long Travel	Cross Travel
a) Material	.....	.....
b) Hardness	.....	.....
c) Depth of hardness	.....	.....
d) Diameter	.....	.....
e) Process of hardening	.....	.....

14. Brakes

	M.H	A.H	C.T	L.T
a) Diameter of the brake	.....	.....	.....	.....
b) Torque rating	.....	.....	.....	.....
c) Type of brake (ac/dc/Thruster)	.....	.....	.....	.....

15. Type of Lifting Hooks (C type/Rams horn)

	Main Hoist	Aux. Hoist
Type of hook	.....	.....
Safety latch on hook	.....	.....
Provided / not provided		
Locking device on : Swiveling hook provided / not provided	.....	.....

16. Type of Buffers (Spring type / Hydraulic)

For crab ..... Size .....

For long travel ..... Size .....

17. Type of Bridge Girder

a) Size .....

b) Type of connection to the end carriage .....

c) Width .....

d) Length .....

18. Type of Platforms on Bridge

Position of access points .....

Emergency escape .....

Type of access platform to cabin .....

Width of platforms .....

19. Type of Operator's cabin:

Fixed / Moving and open / glazed

Location on bridge fixed if, ...

Type of fire extinguisher provided .....

Seating arrangement .....

Position of controllers .....

ELECTRICAL DETAILS

20. Power Supply at the Crane Long Travel Collectors

AC or DC Voltage .....(nominal) + ...percent

No. of phases .....frequency Hz + ...percent

No. of conductors .....

Neutral: Existing / Not existing .....

Type of earthling provided .....

Long travel conductors .....

a) Length .....

b) Size .....

Long travel collectors by: Purchaser / Manufacturer

21. Controls

Whether control is from cabin / pendant / non-conductive

a) Remote control .....

b) Cabin operated .....

c) Pendant: Suspended from crab / fixed point on bridge

d) Type of pendant .....

e) Type of remote control .....

f) Limited range required: Distance .....m

g) Warning device provided .....

h) Any special control arrangements in each drive to be indicated .....

i) Scheme of protection .....

j) Provision of isolating switches and their positions .....

k) Type of master controller used, No. of steps .....

22. Motor Details

(Main Hoist, Aux. Hoist, Long Travel and Cross Travel)

a) Approved manufacturers for motors .....

b) Class of insulation and protection .....

c) Duty classification .....

d) Frame size .....

e) Speed .....

f) Kw rating .....

g) No. of starts / hour .....

23. Main Hoist Limit switches / Aux. Hoist Limit Switches

a) Shunt / counterweight .....

b) Control circuit / Power .....

24. Load Weighing System (Load Cell)

a) Compression type .....

b) Tension type .....

c) Display unit .....

25. Resistance Details	**M.H**	**A.H**	**C.T**	**L.T**
a) Type	.....	.....	.....	.....
b)Rating	.....	.....	.....	.....
c) Steps	.....	.....	.....	.....

26. Type of Traverse Current Collection System

27. Details of Bridge lighting, underbridge lighting provided, warning Lights and / or alarm system Provided.

28. Cabin Facility Provided by :

Fan / Air-Conditioning / Cabin heating / Exhaust / others

29. ENVIRONMENTAL DETAILS

General State of Atmosphere or Climate

30. Average Ambient Temperature

Maximum Temperature .....° C
Minimum Temperature .....° C
Maximum Humidity ....° C

Details of special devices provided to prevent collision of the cranes or their loads or for separating the cranes by a minimum distance in order not to cover stress the gantry structure.

31. DETAILS OF LUBRICATION

a) Type (group / Centralised) .....

b) Capacity .....

32. DETAILS OF WIND CLAMPS

a) Type (Mechanical / Motorised) .....

b) Type of interlocking system .....

33. STRUCTURAL DETAILS

33.1 Rail : Size of rail for CT .....

33.2 Wheel loads :

	LT	**CT**
a) Minimum wheel load	.....	.....
b) Maximum wheel load	.....	.....
c) Spacing of wheels	.....	.....

33.4 Dimensions

Span s .....m; + A2 .....mm

Width of rail head B .....mm

Side clearances X.....mm Y ..... mm
Z ..... mm

Clearances from any obstruction from top of rail C ..... mm

Rail height from floor D .....mm

Dimensions of knee bracking on truss

P1 .....mm P2 .....mm

T1 .....mm T2 ..... mm

Hook travel for
Main hoist H1 .....mm H2 .....mm

Aux. Hoist H3 .....mm H4 .....mm

Position of hook from centre line of rail for

Main hoist E ..... mm F ..... mm

Aux. Hoist E1 .....mm F1 ..... mm

Vertical clearance under side bridge .....K-mm

Position / Height of

Cabin L .....mm M ..... mm

Size of cabin N ..... mm Width ..... mm

Highest point of obstruction L1 .....mm L2 .....mm

Any other site restrictions

34. PAINTING

a) Prime coat .....

b) Two finishing coat .....