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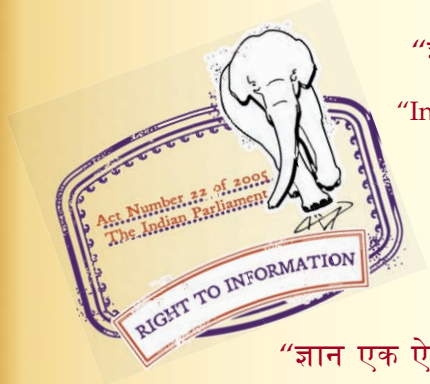

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Indian Standard

CODE OF PRACTICE FOR HEAVY DUTY ELECTRIC OVERHEAD TRAVELLING CRANES INCLUDING SPECIAL SERVICE MACHINES FOR USE IN STEEL WORKS

(First Revision)

UDC 621'874'2-83 : 006'76

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 13

July 1987

Indian Standard

CODE OF PRACTICE FOR HEAVY DUTY ELECTRIC OVERHEAD TRAVELLING CRANES INCLUDING SPECIAL SERVICE MACHINES FOR USE IN STEEL WORKS

(First Revision)

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(*Continued on page* 79)

CONTENTS

		PAGE
0.	FOREWORD	9
	SECTION 1 GENERAL	
1.	SCOPE	10
2.	TERMINOLOGY	10
3.	INDETIFICATION	10
4.	INFORMATION TO BE SUPPLIED	11
	4.1 Information to be Supplied with the Enquiry or Order	11
	4.2 Information to be Supplied by the Manufacturer ...	11
	SECTION 2 MECHANICAL ASPECTS	
5.	DESIGN OF CRANE MECHANISM	11
	5.1 General	11
	5.2 Design on 'Strength' Basis	12
6.	ROPE DRUMS	12
	6.1 Size of Drums	12
	6.2 Grooving of Drums	12
	6.3 Materials for Drums	13
	6.4 Strength of Drums	13
	6.5 Rope Anchorage	14
7.	WIRE ROPES	14
	7.1 Hoisting Ropes	14
	7.2 Factor of Safety	14
8.	SHEAVES	14
	8.1 Sheaves Diameters	14
	8.2 Grooving	14
	8.3 Sheave Guards	15
	8.4 Equalizing Sheaves	15
	8.5 Materials for Sheaves	15
9.	TRACK WHEELS	15
	9.1 General	15
	9.2 Materials for Track Wheels	15
	9.3 Diameter of Wheels	15
	9.4 Flanges	16
	9.5 Width of Tread	16

	PAGE
10. BUFFERS	16
10.1 General	16
11. BOLTS AND SET SCREWS (OTHER THAN THOSE USED IN CRANE STRUCTURE)	17
12. DRIVES	17
13. GEARING	18
13.1 Types	18
13.2 Materials	18
13.3 Design	18
13.4 Fixing	18
13.5 Mounting	18
13.6 Gear Boxes	18
14. BEARINGS	19
14.1 Permissible Types	19
14.2 Capacity and Loading	19
14.3 Housings	19
14.4 Lubrication	19
15. SHAFTS AND KEYS	19
15.1 Design	19
15.2 Mounting	20
16. COUPLINGS	20
17. LIFTING HOOKS	20
17.1 General	20
17.2 Types	20
17.3 Mounting	21
18. OPERATOR'S CABIN	21
18.1 Type and Location	21
18.2 Structure	21
18.3 Cabin Access	21
18.4 Size	22
18.5 Visibility and Field of Vision	22
18.6 Lighting, Heating, Ventilation, and Air Conditioning ...	22
18.7 Seat	22

PAGE

19. MEANS OF ACCESS 23
19.1 General Requirements 23
19.2 Platforms 23
19.3 Ladders 23

20. GUARDING AND WEATHER PROTECTION 23
20.1 Guards 23
20.2 Weather Protection 23

21. PAINTING 23

22. HANDLING FACILITIES 24

SECTION 3 ELECTRICAL ASPECTS

23. MOTORS 24
23.1 Selection of Motor Sizes 24
23.2 Enclosures 24
23.3 Type of Motors 25
23.4 Insulation 25
23.5 Design 25
23.6 Limiting Speeds 25
23.7 Terminals 25
23.8 Accessibility 25

24. CONTROLLERS 25
24.1 General 25
24.2 Rating 26
24.3 Accessibility 26
24.4 Marking and Direction of Operation of Controllers ... 26
24.5 Notching 26

25. BRAKING 26
25.1 Electro-mechanical Braking 26
25.2 Electrical Braking 27
25.3 Brake Magnet Coils 28
25.4 Brake Surfaces 29

26. CRANE CONTROL 29
26.1 General 29

PAGE

26.2 Electrical Protection 30
26.3 Scheme of Control 30
26.4 Control Equipment 34

27. RESISTORS 34
27.1 General 34
27.2 Rating 34
27.3 Fittings 34

28. SWITCHES 34
28.1 Main and Isolating Switches 34
28.2 Auxiliary Isolating Switches and Fuses 36

29. LIMIT SWITCHES AND TRACK SWITCHES 37
29.1 Limit Switches in Hoist Motion 37
29.2 Track Limit Switches 38
29.3 Proximity Warning Device 38

30. DISTRIBUTION BOARDS 38

31. AUXILIARY SWITCHES OTHER THAN ISOLATING SWITCHES ... 39

32. IDENTIFICATION OF CIRCUITS 40

33. DISPOSITION AND HOUSING OF ELECTRICAL EQUIPMENT ... 40
33.1 Electrical Equipment Other Than Resistor Assemblies 40
33.2 Resistor Assemblies 40

34. CONDUCTOR AND COLLECTOR SYSTEMS 41
34.1 Long Travel System 41
34.2 Cross Travel Systems 41
34.3 Cross Travel Conductors 41
34.4 Cross Travel Collectors 42

35. SCREENING 42

36. EARTHING 43
36.1 Responsibility 43
36.2 Method 43
36.3 Bonding 43

PAGE

37. FIXED CABLES AND WIRING 43

37.1 Specifications 43
37.2 Minimum Size 43
37.3 Protection 44
37.4 Installation 44
37.5 Termination 45
37.6 Identification 45

38. LIFTING MAGNET AND EQUIPMENT 45

38.1 General Requirements 45
38.2 Magnets 45
38.3 Magnet Lead 46
38.4 Magnet Couplings 46
38.5 Cable 46
38.6 Cable Drum 46

39. MAGNET CONTROL AND PROTECTIVE EQUIPMENT ... 47

40. MAGNET EARTHING 47

41. AUXILIARY SUPPLIES 47
41.1 Rectifiers 47

42. PORTABLE LIGHTING 48

43. FIXED LIGHTING 48

44. CRANE WARNING LIGHTS 48

SECTION 4 INSPECTION AND TESTING

45. INSPECTION AND TESTING 49

46. TESTS AT MANUFACTURER'S WORKS 49

47. TESTS AT PURCHASER'S PREMISES 49
47.1 Insulation Tests 49
47.2 Tests for Operation 50

48. DEFLECTION TESTS 50

49. OVERLOAD TESTS 50

		PAGE
APPENDIX A	LIST OF THE STEEL PLANT CRANES AND SPECIAL SERVICES MACHINES COVERED BY THE CODE ...	51
APPENDIX B	INFORMATION TO BE SUPPLIED WITH THE ENQUIRY OR ORDER	52
APPENDIX C	LIST OF RELEVANT INDIAN STANDARDS ...	61
APPENDIX D	NOTES ON DESIGN AND SELECTION OF MOTORS ...	67
APPENDIX E	TYPICAL CRANE SERVICE DATA FOR STEEL PLANT CRANES INCLUDING SPECIAL SERVICE MACHINES ...	74

Indian Standard

CODE OF PRACTICE FOR HEAVY DUTY ELECTRIC OVERHEAD TRAVELLING CRANES INCLUDING SPECIAL SERVICE MACHINES FOR USE IN STEEL WORKS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 30 October 1985, after the draft finalized by the Cranes and Allied Appliances Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1967. The necessity for the revision has arisen in view of the experience gained by the industry during the course of the implementation of the standard. In this revision the provisions relating to brakes, motors, control circuits, etc, have been revised so that these components are designed and selected on more rational basis.

0.3 This code covers mechanical, electrical, inspection and testing aspects as related to design, manufacture and erection of electric overhead travelling cranes for use in steel works in order to secure safe, efficient and reliable working of these heavy duty cranes during service. Steel plant cranes and special service machines covered in this standard are listed in Appendix A. Structural design aspects of all types of cranes and hoists are covered in IS : 807-1976*. Mechanical, electrical, inspection and testing aspects of overhead travelling cranes and gantry cranes other than steel work cranes are covered separately in IS : 3177-1977†. Cranes are broadly classified into four classes in IS : 807-1976* depending on duty and number of hours in service per year. In IS : 3177-1977† the different motions of a crane and the design of component parts are required to be treated on the basis of mechanism classification defined in terms of the severity of duties to be performed or average life of mechanism or the component part. The same mechanism has been adopted in this code also.

*Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (*first revision*).

†Code of practice for design of overhead travelling cranes and gantry cranes other than steel work cranes (*first revision*).

0.4 Typical service data of steel plant cranes and special service machines is given in Appendix E.

0.5 This standard keeps in view the manufacturing and trade practice followed in the country in the field. Assistance has also been derived from BS : 3579-1963 'Specification for heavy duty electric overhead travelling cranes and special cranes' published by the British Standard Institution (BSI), London.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

SECTION 1 GENERAL

1. SCOPE

1.1 This code covers design, manufacture and erection of heavy duty electric overhead travelling cranes for use in steel works. Its provisions where applicable, shall also apply to special service machines, such as those listed in Appendix A.

1.2 This standard is not intended for application to cranes for auxiliary duties in steel works which are normally covered by IS : 3177-1977†.

NOTE — The structural portion of this code is covered in classification No. 3 and 4 under 4.3 of IS : 807-1976‡.

1.3 This code is not intended for application to cranes for use in areas where sparks from cranes could lead to explosions.

2. TERMINOLOGY

2.1 For the purpose of this standard the definitions given in IS : 5532-1985§ shall apply.

3. IDENTIFICATION

3.1 Both sides of the crane shall bear one or more plaques on which the following shall be inscribed:

a) Manufacturer's name;

*Rules for rounding of numerical values (*revised*).

†Code of practice for design of overhead travelling cranes and gantry cranes other than steel work cranes (*first revision*).

‡Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (*first revision*).

§Glossary of terms for cranes (*first revision*).

b) The word 'crane' followed by a blank space, so that the purchaser may conveniently insert the number or reference letters he choses for the crane; and

c) The safe working load of each independent hoist of the crane (*see* IS : 6511-1972*).

3.1.1 These plaques shall be readily legible from the ground or floor level. A small plaque shall be located in a prominent position in the cab bearing the following inscription:

a) Manufacturer's name,

b) Manufacturer's serial number, and

c) Year of manufacture.

4. INFORMATION TO BE SUPPLIED

4.1 Information to be Supplied with the Enquiry or Order — Information regarding the conditions under which the crane is to be used, together with the information required in Appendix B, should be supplied with the enquiry or order.

4.2 Information to be Supplied by the Manufacturer — The manufacturer shall supply all tender documents including drawings giving the overall sizes, clearances, end approaches, structural features, travel wheel loads, end carriage buffers, impact forces, wheel spacings, etc.

SECTION 2 MECHANICAL ASPECTS

5. DESIGN OF CRANE MECHANISM

5.1 General — The design of the component parts of the mechanism of each crane motion shall include due allowance for the effects of the duty which the mechanism will perform in service.

5.1.1 In all cases the mechanism shall be classified in accordance with **4.3** of IS : 807-1976†, on the basis of duty, and the design of component parts shall be in accordance with the provisions given herein.

NOTE — The classification of the individual motions of a crane may not necessarily be the same as those of the crane structure, and the classification of the one motion of a crane may differ from that of another motion of the same crane.

*Range of preferred safe working loads for cranes, lifting appliances and related excavator equipment.

†Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (*first revision*).

5.2 Design on 'Strength' Basis — In the design of a component on the basis of ultimate strength it is recommended that the value of stress factor used should be the product of the basic stress factor and the duty factor for the appropriate mechanism class, where the basic stress factor (based on ultimate strength) shall be not less than 5 and the duty factor shall be as given in Table 1 for the appropriate mechanism class.

TABLE 1 DUTY FACTOR AND LIFE FOR MECHANISM

Mechanism Class	Duty Factor			Average Life	
	Strength	Wear	All Motions	Running Time in Hours per Day	Total Life in Working Hours, *Min*
2	1·2	0·5	0·5	6	9 000
3	1·4	0·6	0·5	9	30 000
4	1·6	0·7	0·6	12	40 000

Note — The running time per day and total life relate to mechanism class only.

6. ROPE DRUMS

6.1 Size of Drums

6.1.1 The diameter of each drum, measured at the bottom of the groove, shall be not less than 29 times the diameter of the rope. Grooved drums shall be of such size that there will not be more than one layer of rope on the drum when the rope is in its fully wound position.

6.1.2 The drum shall be of such length that each lead of rope has two full turns on the drum when the hook is at its lowest position, and one spare groove for each rope lead of the drum when the hook is at its highest position.

6.1.3 The drum shall be flanged at both ends and when the rope is fully wound on the drum, the flanges shall project a minimum distance of two rope diameters or 50 mm, whichever is less, beyond the rope.

6.1.4 The lead of the rope shall not exceed 5° (1 in 12) on either side of the helix angle of the groove in the drum.

6.2 Grooving of Drums

6.2.1 Rope drums shall be machine grooved and the contour at the bottom of the grooves shall be circular over an angle of approximately 130°. The radius of the groove shall be larger than the radius of the rope by not less than the appropriate amount given in Table 2.

TABLE 2 RADIUS OF GROOVE IN DRUMS AND SHEAVES
(*Clauses* 6.2.1 *and* 8.2)

DIAMETER OF ROPE mm	INCREASE OVER ROPE RADIUS mm
Up to and including 16	1·0
Above 16 and including 24	1·5
Above 24 and including 28	2·0
Above 28	3·0

6.2.2 The depth of the groove shall be not less than 0·4 times of the diameter of the rope.

6.2.3 The grooves of the drum shall be so pitched that there is a clearance between adjacent turns of the rope of not less than:

1·5 mm for ropes up to and including 12 mm diameter,

2·5 mm for ropes above 12 mm and including 28 mm diameter, and

3·0 mm for ropes above 28 mm diameter.

6.2.4 Grooving shall be finished smoothly and be free from surface defects liable to injure the rope. The edge between the grooves shall be rounded.

6.3 Materials for Drums — Drums shall preferably be made of cast steel or rolled steel of welded construction. The material for drum shall conform to any of the following. If welded construction is used the drum shall be stress relieved:

Material	*Specification*
a) Cast steel	IS : 1030-1982*, Grade 2
b) Mild steel	IS : 226-1975† / IS : 2062-1984‡

6.4 Strength of Drums — Every drum shall be designed to withstand the compressive stress caused by the wound-on rope and the local bending stress caused by the drum at the groove when the rope is wound on. The bending stress due to the beam action of the drum shall also be taken into consideration.

6.4.1 The factor of safety on the ultimate strength of the material used shall be not less than the appropriate values obtained from **5.2.**

*Specification for carbon steel castings for general engineering purposes (*third revision*).

†Specification for structural steel (standard quality) (*first revision*).

‡Specification for weldable structural steel (*third revision*).

6.5 Rope Anchorage — The end of the rope shall be enchored to the drum by a suitable method which should be readily accessible. The number of clamps when used shall not be less than 2 on each rope end.

7. WIRE ROPES

7.1 Hoisting Ropes — The hoisting ropes, unless otherwise specified or agreed to by the purchaser, shall conform to IS : 2266-1977* (*see* Appendix C).

The rope diameter, rope construction and tensile strength shall be as under:

Rope Diameter mm	*Rope Construction*	*Tensile Strength (Min)* kgf/mm²
8, 10	6 × 19	180
12, 14, 16	6 × 37 or 6 × 36	180
18 and above	6 × 36	180

7.1.1 Steel cored ropes shall be used for cranes handling hot metal or where the rope has to be used under water or in corrosive atmosphere.

7.1.2 All wire ropes shall generally be of ordinary lay, right hand, pre-formed and ungalvanized. For grab cranes one rope may have left hand lay and the other right hand lay or non-rotating rope according to IS : 2266-1977*.

7.1.3 Rope working under water and in corrossive atmosphere shall be galvanized.

7.2 Factor of Safety — The factor of safety based on the nominal breaking strength and safe working load of the rope shall be not less than 8 for cranes handling hot metal and 6 for class 3 and class 4 cranes. The duty factors specified in Table 1 shall not apply to this factor of safety.

8. SHEAVES

8.1 Sheave Diameters — The diameter of the sheave at the bottom of the groove shall be not less than 29 times the diameter of the rope.

8.2 Grooving — Sheaves shall be machine grooved to a depth of not less than 1·5 times the diameter of the rope. The grooves shall be finished smoothly and shall be free from surface defects liable to injure the rope. The contour at the bottom of the groove shall be circular over an angle of 130° approximately. The radius of this part of the groove shall be larger than the radius of rope by not less than the appropriate amount given in Table 2.

*Steel wire ropes for general engineering purposes (*second revision*).

8.3 Sheave Guards — Sheaves shall be provided with rigid guards to retain the ropes in the grooves. The guard shall fit close to the flange having a clearance not more than 3 mm or one fourth of the diameter of the rope between the sheave and the inside guard. Bottom block sheaves shall be enclosed except for rope openings.

8.4 Equalizing Sheaves — When the load is supported by more than one fall of rope off the drum and bottom blocks are used, the rope system shall be equalized by using equalizing sheaves or equalizing bars. The minimum diameter at bottom of the groove of an equalizing sheave shall be not less than 17 times the diameter of the rope. Equalizing sheaves or equalizing bars shall be arranged to turn or swivel in order to maintain rope alignment.

8.5 Materials for Sheaves — Material for sheaves shall be same as for drums specified in **6.3**.

9. TRACK WHEELS

9.1 General — Track wheels shall have straight tread. In order to guide the crane (or trolley) effectively and to prevent derailment, they shall have flanges. Where the wheels are flangeless, there shall be guide rollers on both sides of track rails. The wheels shall be mounted in such a manner as to facilitate removal and replacement.

9.2 Materials for Track Wheels — Track wheels shall be of cast or forged/ rolled steel or shall have cast steel centre with steel tyre shrunk on and registered.

The material used shall comply with relevant Indian Standard as appropriate.

Unless otherwise specified by the purchaser, the average surface hardness of wheel tread shall be 350 HB to a depth of not less than 6 mm.

NOTE 1 — On request, the manufacturer shall supply the analysis of each cast for contents of carbon, silicon, manganese, sulphur and phosphorus.

NOTE 2 — If under any unavoidable circumstances wheels of higher hardness or with toughened tread are used, the rails on which they are running shall also be heat-treated to avoid frequent replacement of the same.

9.3 Diameter of Wheels — The tread diameter of wheel shall be not less than that given by the following formula:

$$D = \frac{2W}{a}$$

where

D = tread diameter of wheel in mm,

W = wheel load in kg, and

a = full width of rail head including radii in mm.

9.3.1 The diameter so calculated shall be selected from the following preferred diameters:

315, 400, 450, 500, 630, 710, 800, 900, 1 000 and 1 120 mm.

9.4 Flanges — The dimensions of flanges of track wheels shall be not less than the values given in Table 3. The thickness of flanges of non-guiding wheels if flanged may be less than the values given in Table 3 to be determined by the crane manufacturer.

TABLE 3 FLANGE DIMENSIONS

Diameter of Wheels	Depth of Flange	Thickness of Guiding Wheel Flange at Base
mm	mm	mm
From 300 up to 500	20	20
Above 500 up to 1 000	25	25
Above 1 000	30	30

9.5 Width of Tread — The width of wheel tread shall be greater than the rail head by an amount which shall suitably allow for the known variation in the gantry rail alignment and gantry track span dimensions.

10. BUFFERS

10.1 General — Suitable buffers shall be fitted to each end of end-carriage assemblies. Spring buffers shall also be fitted to arrest the traverse of the crab, and may be fitted on the crab or the bridge. Buffers shall be so mounted to permit easy removal of wheels. Springs in buffers shall have sufficient energy absorbing capacity to bring the unloaded crane/trolley (loaded crane in the case of stiff masted cranes) to rest from a speed of 50 percent of the rated speed at a deceleration rate not exceeding 5 m/s^2. Other types of buffers like hydraulic and resilient plastic buffers may also be used subject to agreement between the manufacturer and the purchaser.

NOTE — In case of stripper cranes, the load on crane shall also be taken into account.

10.1.1 Wooden buffers shall not be used.

11. BOLTS AND SET SCREWS (OTHER THAN THOSE USED IN CRANE STRUCTURE)

11.1 Bolts and set screws in rotating parts shall be locked, but this provision shall not apply to set screws used for locking purposes. Bolts in tension shall be avoided wherever possible.

11.1.1 All holding down bolts shall be adequately locked. Taper pads, spot welded in place, shall be provided on the underside of steel sections which have tapered flanges.

11.2 All bolts and nuts shall be in accordance with the IS : 1364-1984*. Black bolts shall not be used.

11.2.1 All bolts shall be easily accessible. Where inaccessible, heads of such bolts shall be prevented from turning by suitable locking.

12. DRIVES

12.1 All gear shafts shall be supported by two bearings. If a single travel drive is used it shall be mounted as close as practicable to the centre of the span.

12.1.1 The travel driving shaft or shafts shall be supported on self-aligning bearings at approximately 3-m centre or less. Sleeve bearings may be used in place of self-aligning bearings if agreed to between the purchaser and the manufacturer. Shaft couplings shall be as near as practicable to the bearings.

12.1.2 Angular deflection of the lineshaft at torque corresponding to $1\frac{1}{2}$ times the motor torque, during accelaration period shall not exceed 0·26 m of shaft length. In the case of travel drive located at the span centre, 2/3 of the motor torque shall be taken for each half of the shaft.

12.1.3 The shaft shall be easily accessible throughout its length and shall be designed, as far as practicable, in interchangeable lengths, the end and centre sections being as short as possible.

12.1.4 Where applicable, the driving pinions shall not interfere with the removal of travel wheels.

12.1.5 All structural steel faces carrying machinery shall be machined. Where necessary welded snugs shall be fitted against the feet of all pedestals.

12.1.6 When the bridge is a double web box girder with no outrigger girder the support for motor and gear box shall be so designed as to produce no lateral and local bending of web plates.

*Specification for hexagon head bolts, screws and nuts of product grades A and B (*second revision*).

12.2 In case of central long travel drives using rigid couplings, the shaft assembly shall be given a camber of fifth of the bridge camber by adjusting the level of plummer block.

13. GEARING

13.1 Types — All gearing shall be machine cut and shall conform to the relevent Indian Standards (*see* Appendix C).

13.2 Materials — All gears shall be of cast or wrought steel and suitably heat-treated except for worm wheels or worm-wheel rims, which shall be of phosphor bronze and centrifugally cast.

13.3 Design — Gears shall be designed in accordance with the relevant Indian Standards, using the duty factor, given in Table 1 for the appropriate mechanism class as minimum.

13.4 Fixing — Keys in gear trains shall be so fitted and secured that they do not work loose in service. Bores for gears and pinions shall be finish-machined or ground to size after any heat-treatment that may be necessary.

13.5 Mounting — Overhung gears and pinions shall not be used.

13.6 Gear Boxes — All gears shall be completely covered or guarded by covers firmly and substantially attached to brackets or other parts of crane, and shall be oil tight. Gear boxes shall be so designed that the gears which they enclose will automatically be lubricated; the gears shall be readily removable and all practicable measures shall be taken to prevent leakage of oil from the boxes. The boxes shall be of rigid construction and fitted with inspection covers and lifting lugs where necessary. Facilities for oil filling, adequate breathing, drainage and means of indicating clearly the correct and actual oil levels shall be provided.

13.6.1 Gear boxes, forming an integral part of a load bearing structure, shall not be used unless agreed to by the purchaser.

13.6.2 Gear box feet shall be machined and shall be seated and positively located on a machined surface, except where they are integral or shaft mounted.

13.6.3 Manually operated gear change levers shall be positively locked in position. Provision shall be made to prevent the block from overhauling whilst changing gear. Facilities for correct registering and withdrawal of the gear box halves shall be provided.

13.6.4 The internal surfaces of gear boxes shall be painted with oil resisting paint.

13.6.5 Material for the gear box shall be cast steel or mild steel in case of fabricated construction and shall conform to the relevant Indian

Standards (*see* Appendix C). The fabricated gear boxes shall be stress relieved before machining.

14. BEARINGS

14.1 Permissible Types — All bearings used shall be antifriction ball/ roller bearings except otherwise specified.

14.2 Capacity and Loading — Ball bearings and roller bearings shall have rated life calculated in accordance with the manufacturer's recommendations and based on the equivalent running time given in Table 1.

14.2.1 If phosphor bronze bearings are used, the bearing pressure shall not exceed 70 kgf/cm^2 on the projected area. If bearings made of any other material are used, care shall be taken that the appropriate permissible bearing pressure is not exceeded.

14.3 Housings — All bearing housings shall be made of cast or wrought steel bolted to a rigid portion of the crane structure by at least 4 bolts except for intermediate line shaft bearing housings. They shall be split on the shaft centre line to permit removal of the shaft.

14.3.1 If full ring cartridge housings are required for gearbox, ball or roller bearings, this shall be specified. Unless otherwise stated, the sheave bearings shall be mounted on sleeves (or quills).

14.4 Lubrication — Provision shall be made for lubricating all appropriate bearings from points, grouped if possible, and easily accessible from the working platforms of the cranes.

14.4.1 If centralized lubrication is required this shall be specified in which case dual line lubrication system shall be provided with steel tubes having a minimum nominal bore of 8 mm or as specified. Where required the bearing shall be connected to the fixed piping by flexible hoses.

14.4.2 All pipework shall be securely fixed and protected from damage.

14.4.3 Effective protection shall be provided to prevent access of dust to the lubricant and such protection shall also be weatherproof on outdoor cranes.

14.4.4 A lubrication chart shall be provided, indicating all lubricating points and type of lubricant required, and the recommended frequency of lubrication.

15. SHAFTS AND KEYS

15.1 Design — In proportioning shafts, allowance shall be made for

keyways and splines. Changes in section in shafts shall be made with due allowance for stress concentration.

15.1.1 Keys shall be provided with keepers if practicable. Splines and serations shall be of involute or straight sided form, which shall comply with relevant Indian Standards (*see* Appendix C).

15.2 Mounting — All gearing, couplings, brake wheels and other parts shall be pressed on their shafts if keyed. This does not preclude other forms of attachment. Spur pinions may be solid with the shaft.

15.2.1 Keys and keyways shall comply with relevant Indian Standards (*see* Appendix C) except where design considerations may necessitate departure there.

16. COUPLINGS

16.1 All couplings, shall be of cast or wrought steel and shall be designed to suit the maximum torque that can be developed.

16.1.1 Alignment shall be such that solid couplings mate accurately. Flexible couplings shall be initially aligned with the same accuracy as solid couplings.

16.1.2 Flexible couplings shall be fitted between motor shafts and extension shafts.

16.2 Hoist drums shall be connected to gear box out-put shaft by means of flexible hoist drum couplings to cater for misalignment, frame distortion, etc, and also to facilitate removal of hoist drum. For special applications, where flexible drum couplings cannot be used, flexible geared type couplings may be used.

17. LIFTING HOOKS

17.1 General—Lifting hooks shall comply with relevant Indian Standards specifications (*see* Appendix C).

17.2 Types — For loads up to 80 tonnes, shank type plain hooks may be used and above 80 tonnes, hooks of the ramshorn type or the triangular lifting eyes are preferred.

17.2.1 Cranes to handle hot metal ladles shall be equipped with ladle hooks of laminated type fabricated from structural steel plates to IS : 2062-1984*. The ladle hook should be hung from the hanger pin in such a way that the hooks can be laid on the floor horizontally when the ladle beam is lowered for maintenance.

*Specification for weldable structural steel (*third revision*).

17.3 Mounting — The swivelling hooks shall be mounted on thrust bearings. A protective skirt shall be provided to enclose the bearings. The thrust bearings shall be provided with facilities for lubrication. Locking devices shall be provided to lock the hook to prevent its rotation and slippage of load from the hook.

17.3.1 If specified, the hooks shall be provided with closing fingers in which case the hinge lug for the closing finger shall be forged with the hook.

18. OPERATOR'S CABIN

18.1 Type and Location — The operator's cabin may be of the fixed/moving type as required by the purchaser. The fixed type cabins shall be located at the bridge as specified in Appendix B.

18.2 Structure — The cabin shall be rigidily built of structural steel and fireproof material and shall be braced to prevent movement between cabin and supporting members. It shall be supported by rivets or bolts in shear. All steel sheets shall be of 3·15 mm minimum thickness, unless otherwise specified. The floor surface shall be clear of any obstructions. If specified, cabin walls and floors exposed to excessive heat or cold shall be effectively insulated. The head room of the cabin shall not be less than 2 m.

18.2.1 In ladle cranes, other cranes handling hot materials, and outdoor cranes, cabins shall be totally enclosed, unless otherwise specified. Cabins for other cranes shall be semi-enclosed, unless a totally-enclosed cabin is specified. The roof shall, where practicable slope down towards the back of the cabin and shall be proof against oil drips.

18.2.2 The cabin of outdoor cranes shall be weatherproof.

18.2.3 If the cabins are fitted with opening windows, these shall be made to slide unless hinges are specified. If special vision panels are provided in the floor they shall be suitably guarded. Arrangement shall be made to ensure that the whole exterior of the cabin glazing can be safely cleaned. Glasses shall be mounted with proper rubber seals/beadings and shall be able to withstand vibration.

18.2.4 All glazing shall be toughened plate glass of 6 mm minimum thickness conforming to IS : 2553-1971* and shall be installed from the inside.

18.3 Cabin Access — The entrance to the cabin shall be fitted with a door located for safe access. The cabin floor shall be extended outside

*Specification for safety glass (*second revision*).

the cabin on the side containing the door, and if necessary, sideways also to form a platform unless otherwise required. Suitable hand railing should be provided on the platform. The operator's cabin shall not have any obstruction, along the entrance so that it may be possible for the operator to escape in case of any emergency.

18.3.1 Accessibility to the bridge platform shall be through the stairs.

18.3.1.1 The inclination of the stairs shall not exceed 45° to the horizontal. This provision may not be made applicable in case of cabins attached to the trolley.

18.4 Size — The cabin shall be built with a clear headroom of not less than 2 m. The dimensions of the cabin shall be determined by the requirement of housing the control gear, accommodating the driver in a sitting position and allowing free access to the door of the cabin.

18.5 Visibility and Field of Vision — Cabins shall be so designed that under all operating conditions the field of vision of the driver is adequate.

18.6 Lighting, Heating, Ventilation and Air Conditioning — Fixed service lighting shall be installed to provide glare free illumination in the crane cabin.

18.6.1 If specified a robust, fixed, metal enclosed non-luminous electric heater shall be provided in the cabin.

18.6.2 All cabins shall be provided with an air circulating fan of minimum sweep 400 mm. In totally enclosed cabins provisions shall be made for efficient ventilation of the cabin, when all the windows are shut, by means of a robust exhaust fan which shall be adequately guarded. The head room of the cabin shall in no case be less than 2 m.

18.6.3 If specified, totally enclosed cabins shall be fitted with fans and air-conditioning equipment which shall include insulated walls, floor and ceiling. The temperature in the cabin shall be approximately 22 to 25°C. All air-conditioned cabins shall be fitted with a suitable hydraulic door closer.

18.6.4 A suitable CO_2 type fire extinguisher shall also be provided.

18.7 Seat — Where the crane is operated from a seated position, a seat shall be located at such a place in the cabin from where the operator can see his working point clearly and operate the controls conveniently. The seat, however, shall offer no obstacle to the driver whilst taking or leaving it and shall not impede him if he stands up occasionally during operation of the crane.

18.7.1 The cabin shall have a robust seat with a fixed or hinged base and a durable upholstered squab. The seat shall have limited vertical, backwards and forwards adjustments which can be locked, but shall not swivel relative to the controls. It shall be capable of withstanding severe braking forces.

19. MEANS OF ACCESS

19.1 General Requirements — Safe means of access shall be provided to the driver's cabin and to every place where any person engaged on the examination, repair, or lubrication of the crane has to work. Adequate hand-holds and foot-holds shall be provided, where necessary.

19.2 Platforms — Every platform shall be securely fenced with double tiered guard rails having a minimum height of 1·1 m with intermediate member 0·6 m high and 100 mm high toe boards, unless parts of the crane structure provide safety. The platform shall be of sufficient width to enable normal maintenance work to be carried out safely. On bridge platforms, which shall be not less than 0·75 m in width, the fencing shall extend along the full length of the outer edge.

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

19.3 Ladders — Sides of ladders shall extend to a reasonable distance above the platforms, or other reliable hand-holds shall be provided. Ladders shall, if possible, slope forwards. Vertical ladders exceeding 3 m in length shall be provided with back safety guards.

20. GUARDING AND WEATHER PROTECTION

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

20.1.1 Effective guards shall be provided for revolving shafts and couplings unless every set screw, bolt or key of any revolving shaft is sunk, shrouded, or otherwise effectively guarded.

20.1.2 Long travel cross-shafts and couplings above the top platform shall be guarded wherever necessary.

20.1.3 The sheaves of hook blocks shall be guarded to prevent the trapping of a hand between a sheave and the in-running rope, and shall be enclosed except for rope opening.

20.2 Weather Protection — For outdoor cranes all electrical and mechanical equipment shall be adequately protected from the weather. All weatherproof covers shall be easily removable.

21. PAINTING

21.1 Before the despatch of cranes, the complete crane covering structural, mechanical and electrical parts shall be thoroughly cleaned of all dirt, grease, scales and rust and given a single coat of primer. All components shall be given one finishing coat of paint of colour as per

customer's choice. The bright exposed parts of the crane shall be given one coat of rust inhibitor.

21.1.1 Any additional requirements regarding painting shall be as agreed to between the purchaser and the manufacturer.

22. HANDLING FACILITIES

22.1 When specified all outdoor EOT cranes should have portal bracings between the bridge girders covering up to the long travel platform to handle trolley components and long travel motors and gear. Suitable structures at all four corners for handling the track wheels, etc, should be provided. However for all outdoor goliath and semi-goliath cranes, this facility shall be provided.

22.2 All cranes shall be provided with jack pads on both end carriages and trolley structures in such a way so as to facilitate removal of wheel, wheel bogie and compensating bogie.

22.3 When the long travel motors, gear boxes and drive shafts housed inside the bridge girders are not approachable by the handling equipment provided in the building, lifting hooks or a beam shall be provided over the motors, gear boxes and shafts for handling the same.

SECTION 3 ELECTRICAL ASPECTS

23. MOTORS

23.1 Selection of Motor Sizes — Where the duty cycles can be adequately assessed dc or ac motors for any crane motion may be selected so that the motor temperature rise in actual service will not exceed the permissible rise, which later is to be agreed upon between the purchaser and the supplier, taking into account the class of insulation adopted and the ambient temperature at the crane location.

23.1.1 Recommended assumptions and design procedure are set out in the Appendix D for the selection of motors to suit duty cycles and conditions normally found in a steel plant.

23.2 Enclosures — All motors shall be totally enclosd or totally-enclosed fan cooled. ac motors shall conform to IS : 325-1978*. dc motors shall have standard frame sizes.

NOTE — A standard on dc motors is under preparation. Till such time the standard is published dc motor sizes shall be as agreed to between the manufacturer and the purchaser.

*Specification for three-phase induction motors (*fourth revision*).

23.3 Type of Motors

23.3.1 Direct current (dc) motors shall be series wound, unless otherwise specified.

23.3.2 Alternating current (ac) motors shall be slipring induction type, unless otherwise specified.

23.4 Insulation — The motors shall be of Class B insulation or better as classified in the relevant Indian Standard specification.

23.4.1 The permissible temperature rise shall be as laid down in IS : 4722-1968*.

23.5 Design — The motor should be of robust construction. If it is intended to stop or retard the motion of the crane and run the crane by electric braking methods, the motors shall be suitable to withstand this duty. Alternating current motors shall be designed for a pull out torque of not less than 2·75 times full load torque at rated voltage, frequency and 40 percent CDF.

NOTE — The stresses in all components of the hoisting machinery should not exceed $\frac{1}{3}$ yield point of the material for the component under breakdown conditions of the motor.

23.6 Limiting Speeds — Unless steps are taken to limit the main motor speeds to two and one-half times the rated speed or 2 000 rev/min, whichever is less, the motors shall be specially designed for the higher speeds.

23.7 Terminals — Motor leads shall be brought out from motor frame as tails unless otherwise specified and shall be marked in accordance with IS : 4728-1975†. Terminal tails shall be protected from mechanical damage.

23.8 Accessibility — Motors shall be so located that the brush, gear and terminals are accessible for inspection and maintenance, and normal ventilation is not restricted.

24. CONTROLLERS

24.1 General — Controllers shall comply with relevant Indian Standard specification and shall be adequately protected to prevent accidental contact with live parts.

24.1.1 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.

*Specification for rotating electrical machines.

†Terminal marking and direction of rotation for rotating electrical machinery (*first revision*).

24.2 Rating — Controllers shall be rated to comply with relevant Indian Standard specification.

24.3 Accessibility — All controllers shall be so disposed that the contact and terminal arrangements are readily accessible for inspection and maintenance purposes.

24.4 Marking and Direction of Operation of Controllers — Where practicable, controller handle should move in the direction of the resultant load movement. Each controller shall be marked in a permanent manner to show the motion controlled, and wherever practicable the direction of movement.

24.5 Notching — The notching of the controller handle in the 'off' position shall be more positive than the notching in other positions. The handle may be provided with a lock, latch, 'dead man' or spring return feature if specifically requested by the customer.

24.5.1 The control lever shall be provided with stops or catches or both, to ensure safety and facility of operation. A controller fitted with a star wheel shall be regarded as complying with the requirement.

24.5.2 For all motions of the crane, magnetic control with master switches shall be used.

24.5.3 Controller's 'off' position, shall open all supply lines of the respective motors unless otherwise agreed, in which case a warning notice shall be fixed on the controllers.

25. BRAKING

25.1 Electro-mechanical Braking

25.1.1 *General* — Brakes shall be provided for each drive. At least one brake shall be mounted on the input pinion shaft of the gear train.

25.1.2 *Hoist Motion* — Electro-mechanical brake/brakes used for hoist motion shall apply automatically when the power supply fails or when the circuit brake is opened or when the controller handle is brought to the 'off' position.

25.1.2.1 For hoists not handling molten metal and having single drive only the minimum braking torque shall be 150 percent of computed full load torque when the brake is fitted. When two brakes are fitted each shall have braking torque not less than 100 percent of the computed full load torque.

25.1.2.2 For hoists handling molten metal but fitted with twin drives, each drive shall have brakes as specified in **25.1.2.1**.

25.1.2.3 Hoists handling molten metal shall have two brakes on each drive and each brake shall have minimum braking torque of 125 percent of computed full load torque.

For dc-cranes having series motors when two brakes per motor are used, brakes will also be series brakes and connected in series.

For ac-cranes when two brakes per motor are used, the second brake may be fitted with a time lag in which case the braking torque shall not be less than 125 percent of the computed full load torque for each brake.

25.1.2.4 *Braking path* — The braking path of the hoist motion should be within the distance given below with all the brakes applied simultaneously, except the effect of brakes with time lag:

Speed of Hoist S (metre/minute)	*Braking Path* Max (m)
Up to 6	$S/100$
Above 6 and below 12	$S/120$
Above 12	$S/150$

25.1.3 *Long Travel and Cross Travel Motions* — Each drive shall be fitted with an electro-mechanical brake having braking torque not less than 100 percent of computed full load torque.

25.1.3.1 Braking torque shall be checked so that it is capable of arresting the motion within a distance in metres equal to 10 percent of speed in metres/minute when travelling with rated load at rated speed, provided there is no skidding.

25.1.3.2 Long travel motions of outdoor cranes shall be provided with an additional storm brake. The combined braking torque of the service brake shall not be less than the skidding torque assuming a coefficient of friction (μ) = 0·2.

25.1.3.3 For long travel drives anchoring device shall also be provided for outdoor cranes in addition to storm brakes.

25.1.4 All other motions not covered in **25.1** such as slewing shall be provided with effective braking system which can be applied in an emergency or would be applied automatically in the event of failure of power supply.

25.2 Electrical Braking

25.2.1 In addition to specific requirements of this code in regard to the provision of electro-mechanical brakes, and irrespective of the supply current system, electrical braking is permissible and recommended on all motions of electrically operated cranes.

25.2.2 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 power failure and in the case of emergeney.

25.3 Brake Magnet Coils — All magnet coils shall be fed from dc supplies, unless otherwise specified in Appendix B, and the rating of brake magnet coils shall be as given in Table 4 unless otherwise specified in Appendix B.

TABLE 4 BRAKE MAGNET COIL RATINGS

WINDING	BRAKE DUTY	RATING
Shunt	Emergency	Conditions (with economy resistance inserted where necessary)
Shunt	Intermittent operation, any motion	One hour
Series	Hoist	Half an hour

25.3.1 The brake shall operate at the voltage and current values specified in Table 5. Shunt magnets shall meet the requirements when the coils are at a temperature which corresponds to energization under rated conditions.

TABLE 5 BRAKE MAGNET OPERATING VOLTAGES AND CURRENTS

WINDING	dc MAGNETS	ac MAGNETS
Shunt	Lift at 80 percent rated voltage Hold at 50 percent rated voltage	Lift at 80 percent rated voltage Hold at 50 percent rated voltage
For series resistor	Lift at 40 percent rated current	
Series or potentiometer control	Hold at 15 percent rated current	

25.3.2 The temperature rise of coils shall not exceed that permitted by relevant Indian Standard for the class of insulation employed.

25.4 Brake Surfaces — The rubbing surfaces of brakes shall be smooth and free from defects. The temperature attained by the rubbing surfaces under service conditions shall be such that their operation is not impaired.

26. CRANE CONTROL

26.1 General — Automatic control of acceleration shall be provided for all crane motions, unless for any motion another control system is specified.

26.1.1 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. The type of control to be used shall be agreed between the manufacturer and the purchaser.

26.1.2 When the emergency stop push botton is operated, the main circuit-breaking device common to all motions shall be tripped instantaneously and, in the case of dc cranes, rheostatic braking shall be applied to the hoist motions. When any circuit-breaking device is open no main pole on the nominally dead side shall be made alive by a parallel circuit.

26.1.3 Any shunt brake shall be so connected that it will be applied when the main circuit-breaking device is open irrespective of the position of the controller. If required by the purchaser, each control circuit shall be electrically in-erlocked with all associated shunt brakes to prevent power being applied to the motion when the brakes are not energized.

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

26.1.4 While calculating the number of rotor contactors, peak accelerating/decelerating torques and pull out torque of the motor should be taken into account.

26.1.5 For creep lowering speed on hoisting motion, relatively flat speed control shall be provided and the type of control to be used shall be agreed between the manufacturer and the purchaser.

NOTE 1 — Motors' powers computed in Appendix D have been multiplied by a service factor to make the motor thermally capable for the duty condition. In ordering control, the crane manufacturer should notify the control manufacturer of computed motor-power without service factor for selection of components, for example, contactors, switches, overloads etc. 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 crane.

NOTE 2 — If specially required by the purchaser, the drive motor should be protected against overheating by means of thermistors embedded in motor windings. Matching thermistor trip relay should be provided in the control panel.

26.2 Electrical Protection — Suitably located efficient means shall be provided to protect every part of a system from excess current and voltage to prevent danger or damage.

NOTE — Main circuits are those which carry main motor or magnet current. Control circuits are those which are used for control equipment for main motor or magnet.

26.2.1 *Control Circuit* — If the mains 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. One pole of this supply shall be earthed and the contactor and the relay coil shall be adopted to prevent maloperation owing to sneak circuits or earth faults. For master control operated cranes the control voltage shall not be more than 240 V. For cranes fed through dc downshop lead having voltage more than 240 V, the control voltage may be the same as downshop lead voltage.

26.3 Scheme of Control — 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 out the crane supply.

26.3.1 If drums controllers or master controllers are used for the control of all scheme motions, the protective equipment shall comply with Scheme B.

26.3.1.1 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 overcurrent of lower value.

26.3.1.2 Operation of any of the above protective devices shall automatically apply the electro-mechanical brakes on the relevant motion.

26.3.1.3 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.

26.3.1.4 An indelible circuit diagram of the protective equipment shall be provided in the electrical equipment compartment.

Scheme A

a) *Switchgear Common to all Motions* — The main contactors or main circuit-breaker shall open all lines. If a main-circuit

breaker is used, it shall be hand operated, unless otherwise specified, fitted with no-volt release and rated to carry at least the combined full-load currents of the two motions using the largest power (kW) working together with associated auxiliary loads, such as lifting magnets. It shall be prominently labelled 'Main Circuit-Breaker'. The circuit-breaker shall be fitted with automatic re-set bimetal over-load releases for protection against sustained overload and magnetic type instantaneous releases for protection under short-circuit conditions on three phases. The breaker shall have adequate 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.

b) *Switchgear for Individual Motions* — Each motion shall be separately protected and provided with an under-voltage release 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 percent of the full load current of the motor, after a time-lag of not more than 10 seconds.

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 to the 'off' position.

Scheme B

a) *Switchgear Common to All Motions* — All motions shall be controlled by common main contactor or contactors or trip free circuit-breaker or circuit-breakers fitted with no volt release and rated to carry the combined full-load current of the two motions using the largest power (kW) working together with auxiliary loads, such as lifting magnets.

b) *Protective Device for Individual Motions* — Any motor having its power less than one-third that of the largest motor served by the same common overload release, shall be protected by a separate overload release.

Adjustable overload releases shall be provided to trip the main contactor or contactors or circuit-breaker or circuit-breakers and shall be connected as close to it (them) as possible. The minimum provision

for overcurrent protection shall be:

a) One instantaneous release in a common line feeding all motions set to trip the main contactor or contactors or circuit breaker or circuit-breakers instantaneously when the current rises to 250 percent 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 percent of the full load current of the line, after a time-lag of approximately 10 seconds.

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.

26.3.2 *Thyristor Control* — In case thyristor control is used for cranes in any of the motions according to the requirements of the customer, the manufacturer shall ensure the following features:

a) The thyristors shall be protected by fast acting semi-conductor fuses having I^2. t value considerably lower than that of thyristors. These fuses shall be continuously supervised so that blowing-off of any fuse results in tripping of the circuits.

b) The thyristors shall be suitable to carry at least 200 percent of the motor current of the drive concerned rated at $S3$-40 percent. The P.I. V of the thyristor shall be 2·5 times the system peak voltage appearing across the thyristors. The factor 2·5 takes into account the variations in line voltage.

c) Each thyristor shall be protected by RC snubbers network so as to absorb the surges generated out of hole storage effect. Line surge suppressors may be used to limit the over voltage generated out of external surges in consultation with the user.

d) The drive system shall be protected against overload by means of thermal or oil dashpot type magnetic overload relay with inverse characteristics having adjustable setting range. It shall also be protected against over-current by means of instantaneous acting over-current relay having adjustable setting range of 200-250 percent of the rated current. Solid state overload protection may be used subject to agreement with the user.

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 contactors.

This requirement will not be applicable in case reversing operation is achieved through thyristors.

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

g) Whenever armature reversal with contactors for thyristorized dc-drive system/stator reversal with contactors for thyristorized ac-drive system is considered for hoist drive, the drive shall be protected against free-fall condition of the load during switching 'ON' by ensuring that a preferred switching state of the reversing contactors prevails during switching 'ON'.

h) For achieving smooth acceleration of the drive mechanism, ramp function generator shall be used.

j) Wherever necessary, deration in the motor rating shall be considered both for ac/dc-motors.

k) The control circuit shall be so designed as to ensure that brakes are applied near about zero speed condition.

m) Test points shall be available in the control 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 function.

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

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 trip relay shall be provided in the control panel.

26.3.2.1 *Special protection for direct current drive system*

a) To minimize 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 P.U. (inductive drop) across the choke lies between 2 to 4 percent. 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 smoothening chokes of sufficient inductance, wherever required, depending upon motor design.

c) In case of 4 quadrant drives, to protect against inverter commutation failure, while the drive is working in regenerating mode, it is desirable that branch thyristor fuses are used. However, where it is not possible to use branch thyristor fuses, there shall be at least one semi-conductor fuse on the dc-side of the converter in addition to the semi-conductor fuses on the ac-side.

d) It is very essential that while switching on the system, the following sequence is adhered to:

1) Synchronizing supply is switched 'ON',
2) Field circuits are established, and
3) ac/dc-contactors are switched 'ON'.

26.4 Control Equipment — It shall be in accordance with relevant Indian Standards, wherever applicable (*see* Appendix C).

26.4.1 *Control Equipment for dc-Series Motors* — Contactors, switches and allied electrical components shall be selected on the basis of nominal power (in kW) of the motor.

26.4.2 *Control Equipment for ac-Motors* — The selection of contactors shall be made on the basis of *S*3-40 percent rating arrived after applying appropriate service factor to the computed power of the motor. The other components may be selected on the basis of computed power without applying service factor.

26.4.3 The contactors selected under **26.4.1** and **26.4.2** shall have the stipulated contact life as may be specified by the user.

27. RESISTORS

27.1 General — Resistors shall be adequately protected to prevent accidental contact with live parts.

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

27.2.1 The effect of using plugging as a service brake shall be taken into account in determining the size of resistors.

27.2.2 Resistor shall be rated according to the service conditions and the class of crane as specified by customer.

27.3 Fittings — Resistors shall be enclosed in well ventilated housings and, wherever necessary, be fitted with suitable covers.

27.3.1 Resistors shall be mounted on frames and protected and arranged in such a way that the boxes can be easily replaced. Frames shall be of steel and shall be built to withstand mechanical forces imposed by the crane under service conditions.

27.3.2 The connections to resistor terminals should be accessible and should have provisions for adjustment.

27.3.3 Resistor elements shall resist corrosion and shock.

28. SWITCHES

28.1 Main Isolating Switches — Main switches used for isolating shall comply with the relevant Indian Standards. The main metal-clad

isolating switch shall be provided on the crane bridge in an accessible position and connected directly to the long-travel collectors or terminal box in case flexible cables are used. The switch shall be located as close as possible to the long-travel collectors or terminal box, unless its position be otherwise specified. On fixed cab cranes (*see* Fig. 1) it shall isolate all circuits, except the crane lighting circuits, warning lighting circuits, communication circuits; and in ac cranes, the circuit of the transformer supplying the portable lighting socket outlets. On moving cab cranes, it shall isolate all circuits except bridge lighting circuits, warning lighting circuits, and in ac cranes the circuit of the transformer supplying the portable lighting outlets. This isolating switch shall be unfused, unless high breaking capacity fuse protection is specified.

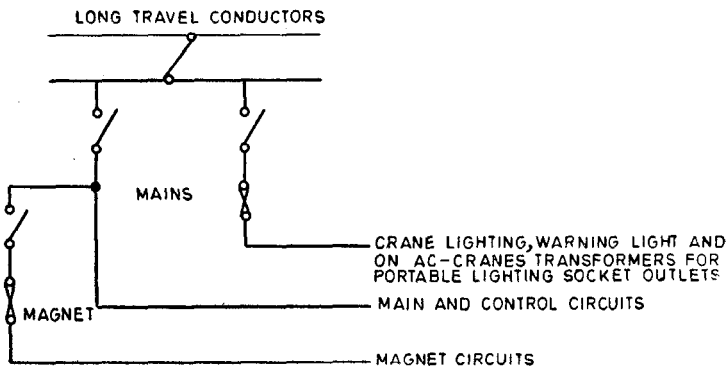

FIG. 1 DIAGRAM OF MAIN ISOLATING SWITCHES AND FUSES REQUIRED FOR FIXED — CAB CRANES

28.1.1 On moving cab cranes (*see* Fig. 2) an additional main unfused metal-clad isolating switch shall be provided on the cab structure in an accessible position outside the crane cab and connected directly to the cross-travel collectors or terminal box in case flexible cables are used. The switch shall be located as close as possible to the cross-travel collectors, unless its position be otherwise specified. It shall isolate all circuits, except the crab lighting circuits, circuits arranged to operate warning devices and on ac cranes the circuit to the transformer for the portable lighting socket outlets on the crab.

28.1.2 Each of the above main isolating switches shall be rated to carry at least the combined full-loads currents of the two motions of the crane using the largest power (kW) working together with auxiliary loads such as lifting magnets and shall be provided with a means for locking it in the 'OFF' position of the switch. The switch cover shall be interlocked with the operating handle, so that it may not

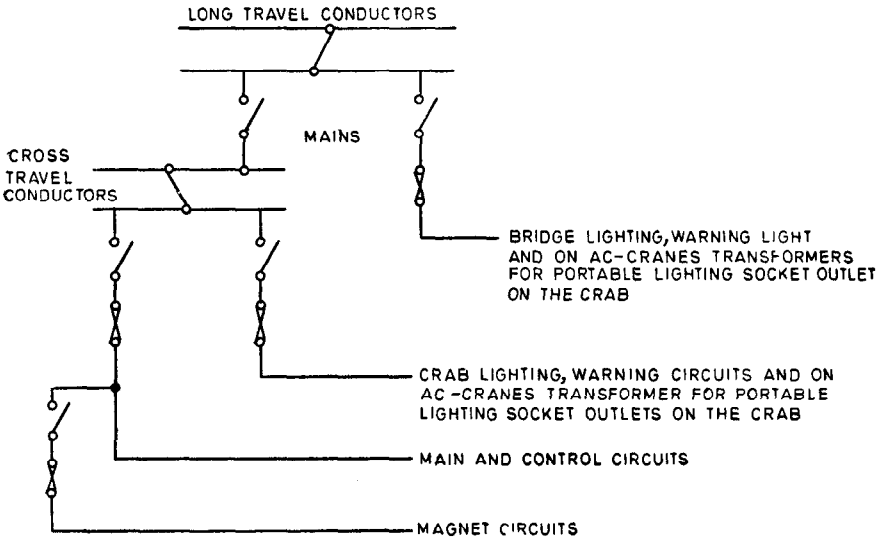

FIG. 2 DIAGRAM OF MAIN ISOLATING SWITCHES AND FUSES REQUIRED FOR MOVING-CAB CRANES

be removed or opened when the switch is closed. Live terminals inside the switch shall be shielded to prevent accidental contact. A pair of neon type pilot lamps or other device in duplicate, indicating when the supply to the crane control circuits is live, shall be provided in a position visible to the driver from his normal working position.

28.1.3 If specified, the main isolating switch on the bridge shall be fitted with a pair of auxiliary contacts which will be closed when the main switch is open and *vice-versa*, to operate the crane warning lights.

28.2 Auxiliary Isolating Switches and Fuses—Auxiliary switches used for isolating shall comply with the relevant Indian Standards (*see* Appendix C).

28.2.1 If specified, an isolating switch shall be provided to isolate all supply lines to the main circuits of each motion. Double-pole high breaking capacity fuses shall be provided on each motion control panel. If specified a double-pole isolating switch shall be provided on each motion control panel to isolate the control circuits. Miniature circuit-breaker as an alternate to control switch fuse is also permissible.

28.2.2 Metal-clad isolating switches with cartridge fuse protection in all lines shall be provided to isolate all supply lines to each of the

following distribution boards or circuits where they exist. The cartridge fuses shall comply with the relevant Indian Standards.

a) *Fixed cab cranes*

1) Distribution board for all crane lighting circuits including warning lighting circuits.

2) Distribution board for auxiliary circuits other than lighting circuits.

3) Magnet circuits.

b) *Moving cab cranes*

1) Distribution board for bridge lighting circuits including warning lighting circuits.

2) Distribution board for all crab lighting circuits.

3) Distribution board or boards for auxiliary circuits other than lighting circuits.

4) Magnet circuits.

28.2.2.1 In fixed cab cranes, the crane lighting circuit isolating switch shall be connected directly to the long-travel collectors and located in the immediate vicinity of the main isolating switch on the bridge.

28.2.2.2 In moving cab cranes, the bridge lighting circuit isolating switch shall be connected directly to the live side of the main isolating switch with cables as short as possible. The switch shall be located on the bridge in the immediate vicinity of the main isolating switch. The crab lighting circuit isolating switch shall be connected directly to the cross-travel collectors and located in the immediate vicinity of the main isolating switch on the crab.

29. LIMIT SWITCHES AND TRACK SWITCHES

29.1 Limit Switches in Hoist Motion

29.1.1 *Cranes with dc-Series Motors* — The final switches to be provided in the power circuit shall be of self-resetting type and shall initiate dynamic braking when tripped. If specified by the user, provisions shall be made in the control circuit to have an audio-visual annunciation to indicate that the final limit switch has operated.

29.1.2 *Cranes with ac-Motors* — The final limit switch which shall trip the main incoming breaker/contactor shall be of manual reset type, if used

in the control circuit. Provision shall be made to by-pass the limit switch temporarily for emergency lowering of hot metal. While by-passing only lowering motion shall be possible.

29.1.2.1 In case where final limit switch is used in the power circuit the same may be of manual or self-resetting type. If self-resetting type is used, there shall be a provision for audio-visual annunciation to indicate its operation, if specified by the user.

29.1.3 If the ultimate limit switch is shunt-connected it shall control the protective panel circuit-breaking device. No two-shunt limit switches shall control the same circuit-breaking device.

29.1.4 If occassional abnormally high lifts are required, arrangements may be made if specified in **B-6.5** (f) for by-passing the first limit switch. Under such condition, hoisting should be possible at slow speed only when by-passing button is kept pressed.

29.2 Track Limit Switches — If specified, one or more track switches shall be fitted to the bridge to give warning of approach to a danger area. They shall be operated by suitable devices to be fixed to the crane gantry as required and shall either operate an audible warning signal or trip the main circuit-breaker on the crane, as specified in Appendix B. Track switches shall be so arranged that they can be readily tested. Strikers shall be so arranged as to prevent damage of the limit switch on over travel due to impact.

29.3 Proximity Warning Device — If specified, one or more devices shall be fitted to the bridge of the crane to give warning of the approach to danger, or another crane.

30. DISTRIBUTION BOARDS

30.1 Metal clad distribution boards incorporating adequate protection in all lines, except those directly connected to earth, shall be provided as detailed below to feed the following auxiliary circuits where they exist. Distribution boards shall comply with relevant Indian Standards, except that semi-enclosed fuses shall not be used.

a) *Fixed Cab Cranes*

1) One distribution board for crane lighting circuits as follows:

Cab service and maintenance lighting; cab and bridge approaches and electrical equipment compartment lighting; warning lights; in ac crane, the step down transformer supplying the socket outlets and walkway, and bridge lighting for illuminating the floor area.

2) One distribution board for cab heating circuits, fan and air-conditioning circuits, if provided.

b) *Moving Cab Cranes*

1) One distribution board for bridge lighting circuits, as follows:

Warning or signal lights; in ac cranes, the stepdown transformer supplying the bridge socket outlets, and walkways and bridge lighting.

2) One distribution board for crab lighting circuits, as follows:

Cab service and maintenance lighting; cab and bridge approaches and electrical equipment lighting and in ac cranes, the step-down transformer supplying the crab socket outlets.

3) One distribution board for cab heating circuits, fan and air-conditioning circuits.

30.2 Distribution boards shall be located as close as possible to the isolating switches controlling them.

31. AUXILIARY SWITCHES OTHER THAN ISOLATING SWITCHES

31.1 Each auxiliary circuit shall be provided with a totally enclosed lighting switch component complying with relevant Indian Standard (*see* Appendix C). These auxiliary switches shall be located as follows:

a) For the equipment in the cab, such as fans and air-conditioners;

b) For the electrical compartment lighting, at the door of the compartment;

c) For the cab approaches, bridge approaches, and bridge walkway lighting such that an operator can illuminate the approaches or walkways without traversing them;

d) For the bridge lights on the crane bridge, at the crane entrance platform in fixed-cab cranes and on the bridge in moving cab cranes; and

e) Non-fusible double pole emergency switches should be connected in series for opening the circuit breaker or main contactors on the protective panel. These switches when 'OFF' will open both the main lines of the protective panel control circuit and will be located at the following places — one in driver's cab within the easy reach of the driver and one on each of the landing corners of the end carriages to be easily accessible to a person when

boarding the crane or getting down from it. Additional switches shall be provided if found necessary and when asked for.

32. IDENTIFICATION OF CIRCUITS

32.1 All switches and fuses shall be adequately labelled to facilitate the identification of the circuits. All panels, controller and resistors are to be properly marked for each motion. All main and control wires shall be ferruled at both ends, as per drawing for quick identification. All elements of the controller and panels are to be clearly marked by furnishing functional nomenclature at the devices. All equipment terminals shall be numbered and tagged.

33. DISPOSITION AND HOUSING OF ELECTRICAL EQUIPMENT

33.1 Electrical Equipment Other Than Resistor Assemblies — If electrical equipment is mounted in the open, it shall be of the enclosed type in weatherproof enclosure with provision for easy access to the parts inside.

33.1.1 Control panels and other electrical equipment should be so located that there is no chance for oil from the gearboxes, to drip on them.

33.1.2 The compartment or units shall neither impede the maintenance of the long-travel drives, nor be mounted on the bridge platform occupied by the cross-travel collector gear. The thoroughfare between the different parts of the crane or between any portion of the crane and the exit platform shall not entail passage through the compartment or be impeded by any control unit.

33.1.3 Control panels or units shall be so spaced that efficient maintenance may be performed, and shall withstand the mechanical forces imposed by the crane under service conditions.

33.1.4 The compartment shall be constructed of steel sections and plates, or other fireproof material of adequate mechanical strength. It shall be drip proof, adequately ventilated and lit, and in addition for outdoor cranes, weatherproof. If windows are provided, wired or toughned glass shall be used and it shall be possible to clean all glass surfaces without danger.

33.2 Resistor Assemblies — Resistor assemblies shall be so mounted as to ensure an adequate flow of cooling air and shall be mounted outside the main contactor compartment.

33.2.1 Resistor assemblies shall not impede the maintenance of the long-travel drives or access to the plateforms of the crane, and shall be arranged so that efficient maintenance may be performed on each unit.

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

34. CONDUCTOR AND COLLECTOR SYSTEMS

34.1 Long-Travel System — The long-travel collectors shall be provided by either the purchaser or the manufacturer, as stated in Appendix B. In the former case, details of mountings on the bridge structure shall be given by the purchaser; in the latter case, all details relating to the long-travel conductors shall be as specified by customer, and the manufacturer shall provide the type of collector gear specified in Appendix B. The gap between the current collector and the adjacent live or earth part shall not be less than 50 mm.

34.1.1 If trolley arms are specified, they shall be of the short arm type with limited arc of travel. If two single trolley arm collector for each long-travel conductor are specified, one trolley arm shall be arranged to be leading and one to be trailing, and the arms shall be arranged to diverge.

34.1.1.1 Slipper heads shall be easily replaceable.

34.1.2 In the event of a long-travel collector arm leaving the long-travel conductor, it shall not be possible for the supply to become short-circuited or earthed. The insulation of the arm shall be capable of withstanding damage by prolonged abrasion against the long-travel conductor.

34.1.2.1 Long travel collectors shall be mounted on a rigid structure on the crane bridge.

34.1.3 Safe and convenient means of access shall be provided for the maintenance of all collectors. Flexible cables may be provided for long-travel power system if required by the purchaser.

34.2 Cross-travel System — The cross-travel system shall be in accordance with **34.3** and **34.4** unless the flexible-cable type is specified. In the latter type all cables shall comply with the provisions for fixed cables given in **37**.

34.2.1 The conductors shall consist of insulated multiconductor (or several single conductor) cables with permanent termination on the bridge and on the trolley. The flexible trailing cable shall have ample length and shall be supported by means of properly designed clamps. These clamps shall be fitted on rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stresses or wear on the suspended cable. Any other method of clamping may be adopted by mutual agreement between the manufacturer and the purchaser.

34.3 Cross-Travel Conductors — Cross-travel conductors for the main crab shall be mounted on the main bridge platforms and not inside the

main girders. The gap between the current collector and the adjacent live or earth part shall not be less than 50 mm.

34.3.1 The cross-travel conductors for auxiliary crabs shall be mounted above the level of the auxiliary crab rails.

34.3.2 The cross-travel conductors shall be arranged so that they are all accessible for maintenance from at least one side along their whole length.

34.3.3 The cross-travel conductors shall be as specified in Appendix B. Trolley wires shall have a minimum diameter of 8·8 mm and shall comply with relevant Indian Standard (*see* Appendix C).

34.3.4 Unless otherwise specified, the maximum current density shall not exceed 0·42 A/mm^2 for rolled steel sections and 2·5 A/mm^2 for copper wires.

34.3.5 Insulators shall be spaced not more than 3 m apart along each conductor.

34.3.6 Where wires are used, intermediate supporting insulators shall be so designed that there shall be no possibility of the cross-travel wires leaving them in the event of a crane collision. Intermediate cross-travel insulators shall be mounted on rigid brackets. Adequate tensioning devices shall be installed at the wire ends and there shall be no possibility of adjacent wires coming into contact.

34.3.7 End insulators shall be stressed in compression only and the insulators shall be easily replaceable and accessible for cleaning.

34.3.8 The conductors shall be permanently labelled to correspond with the numbering system adopted for the crane wiring.

34.4 Cross-Travel Collectors — The cross-travel collectors shall be provided by either the purchaser or the manufacturer as stated in Appendix B. In the former case, details for mountings on the crab shall be as given in Appendix B, in the latter case, the manufacturer shall provide collector gear of the type as specified in Appendix B.

34.4.1 Two collector power poles shall be provided for the magnetic supply.

34.4.2 Collector gear shall be rigidly mounted so as to provide reasonable accessibility to all parts for maintenance purposes. Collector heads shall be readily renewable and shall be positioned so as to provide adequate contact with the conductor for any position of the crab.

35. SCREENING

35.1 Bare conductors for the purpose of picking up current shall be

placed out of reach or screened to prevent accidental contact by persons using the crane. This includes screening (which in some cases may be in the form of local guards fitted to the crane) to prevent accidental contact with bare conductors by persons entering, occupying or leaving the crane cabin or platform. If bare conductors are mounted on the crane bridge adjacent to a walkway along the bridge they shall be completely screened from this walkway.

NOTE — In cases where there may be danger to persons working at floor level by making contact with live conductors whether directly or indirectly through handling long lengths of conducting materials, the Factories Act requires that the down-shop conductors shall be screened to prevent such contact throughout their full length. The crane maker is not responsible for compliance with this provision, so far as the down-shop leads are concerned unless called for by the purchaser at the time of tendering. In designing the structure of the crane, clearance should be provided to permit screening of the down-shop leads to be added later, should this become necessary.

36. EARTHING

36.1 Responsibility — The purchaser shall undertake the responsibility for earthing the gantry or the earth long-travel conductor.

36.2 Method — The crab and bridge structures shall be adequately earthed.

36.2.1 Earthing-collector gear shall be identical with current-collector gear (*see* **34**).

36.2.2 For earthing of the magnet , *see* **40**.

36.3 Bonding — All metallic components located on the crab which are not intended to carry current shall be solidly bonded to the crab structure, and all such components on the bridge shall be solidly bonded to the bridge structure.

NOTE — For normal conditions the crane wheel may be considered to make an effective earth with the rails. If a deposit on the rails arising from infrequent use, dust, corrosive atmosphere, or other causes is likely to lead to inadequate contact, an additional collector suitable for engaging with an auxiliary earthing trolley-wire or rail, should be provided. Gantry rails should be bonded.

37. FIXED CABLES AND WIRING

37.1 Specifications — Unless otherwise agreed, cables shall be of copper or aluminium complying with the appropriate Indian Standards (*see* Appendix C).

37.2 Minimum Size — Cables having conductors smaller than 2·5 mm^2 nominal equivalent copper area of cross-section, shall not be used for control circuits. For power circuits cables having conductor cross-section less than 4 mm^2 copper or 10 mm^2 aluminium shall not be used.

37.2.1 Where cranes are equipped with one hour rated motors, the armature cables may be uprated by a factor of 1·4 above the ratings of continuous duty. Similarly for cranes equipped with half hour rated motors an uprating factor of 1·7 may be used. Where the cranes are equipped with intermittent duty rated motors the factors for up-rating the stator cable shall be $\frac{8{\cdot}75}{\sqrt{IDF}}$, where *IDF* is the intermittent duty factor of the motor. The cables for rotor/armature resistor circuit carry current during acceleration period only and, therefore, have higher uprating factors. For 10 and 5 minutes rated resistors, the uprating factors of 1·5 and 2, respectively may be used.

37.2.1.1 While selecting cables consideration should be given to factors like ambient temperature, grouping and disposition of cables, and the limitation of the voltage drop.

37.3 Protection — All cables shall be adequately protected against mechanical damage and metal trunking may be used if desired. If electric conduit is used it shall be welded conduit complying with the to relevant Indian Standard (*see* Appendix C).

Where cables are drawn into a steel tube, the steel tube shall be heavy gauge, welded or solid-drawn, screw-jointed and drained.

37.3.1 For outdoor cranes, except where flexible unarmoured cables are essential, cables shall be either armoured or enclosed throughout their length in galvanized trunking or conduit either flexible or rigid. A flexible metallic tube or duct shall not be used as an earth connection. Taped and braided varnished cambric insulated cables shall not be used for out-door cranes.

37.4 Installation — The cable and wiring systems for each motion shall be independent and common returns shall be avoided. Main cables and controlled wiring shall be effectively separated. Where there is incidence of direct radiation of heat, the cable shall be protected by a shield of sheet metal.

37.4.1 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. Where mineral insulated metal cables are subject to the effects of high transient voltage they shall be suitably protected by the use of surge limiting devices.

37.4.2 Cables remaining alive when a main isolator is opened shall have metallic protection and shall be separately installed.

37.4.3 Cable runs shall not be installed in any place where they will impede the crane driver's field of view.

37.4.4 Due consideration shall be given during the design of the crane

to make adequate provision for cable runs and to avoid cable runs in locations where high temperatures and mechanical damage are likely to be experienced under service conditions. The cables should be easily accessible and should not hamper the movement of persons on the crane.

37.4.5 Adequate precaution shall be taken to prevent the ingress or collection of water or oil in any part of a conduit or trunking system.

37.5 Termination — Where trunking is used it shall extend into the electrical compartment or enclosed units. It shall be terminated as close as practicable to motors, collector gear and master controllers. Where junction boxes are necessary, as at motors equipped with flexible tails, these boxes shall be rigidly fixed to the crane structure close to the end of the trunking. Flexible or rigid conduit may be used to protect the cables between the trunking and the connected apparatus.

37.5.1 Conduit systems shall be continuous to switch boxes and conduit outlets.

37.5.2 Cable tails shall be adequately insulated and mechanically protected, and shall be suitably supported with insulated cleats, where necessary, to ensure rigidity.

37.6 Identification — Cores of multicore cables shall bear a distinguishing mark or tape.

37.6.1 Cable ends and terminals shall be ferruled at both ends and permanently marked with numbers or letters to correspond with the diagrams of connections to be supplied.

38. LIFTING MAGNET AND EQUIPMENT

38.1 General Requirements — The crane shall be fitted with lifting magnets and magnet control and protective gear, if specified in Appendix B.

38.1.1 If specified in Appendix B, due allowance shall be made on the crane structure to permit the future fitting of this equipment.

38.2 Magnets — The type and size of magnets shall be in accordance with details specified in Appendix B. Each magnet shall be water-tight and shall be provided with a water-tight terminal box having:

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 interfering with the magnet lead inlet.

d) thickness of box and cover not less than 19 mm, and

e) a non-linear type discharge resistor of adequate rating.

38.3 Magnet Lead — The magnet lead shall be a flexible cable in accordance with 37 and shall be a two-core cable, unless earthing of the magnet is as detailed in 40 when a three-core cable shall be used.

38.3.1 If specified in Appendix B, the magnetlead shall be protected by rubber hose complying with relevant Indian Standard (*see* Appendix C).

38.3.2 The magnet lead shall be so arranged that it does not become unduly slack or taught during normal operation of the crane.

38.4 Magnet Couplings — The type of magnet coupling shall be in accordance with the details specified in Appendix B, but if no particular type is specified, the coupling shall comply with the following requirements:

a) The coupling shall be of rugged construction and so arranged as to be protected against abuse both when connected and disconnected,

b) At the moment of breaking the contacts shall be enclosed by insulating material,

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

d) If an earth connection is required it shall break last on uncoupling, and

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

38.5 Cable — The magnet cable shall be rigidly attached to the bottom block by a suitable cable clamp, at a point just above the magnet coupling.

38.6 Cable Drum — The magnet cable drum shall be:

a) arranged so that the 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 hoisting ropes; and

c) capable of accommodating and paying out the length of cable necessary for the magnet to reach its lowest position, including any fall below floor level specified in Appendix B.

38.6.1 Where power is fed to the magnet by a 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.

38.6.2 A spare slip-ring complete with brush gear arrangement may be provided, if specified.

39. MAGNET CONTROL AND PROTECTIVE EQUIPMENT

39.1 The magnet shall be controlled either by direct-on-line control or by potentiometer control as specified in Appendix B. In both methods of control the magnet shall be demagnetized by current reversal.

Direct-on-line control shall be in accordance with the following:

a) The magnet shall be energized by switching it across full mains voltage and discharge resistance shall be connected on switching off.

b) Control shall be effected by means of a master controller and magnetic contactor panel. The controller shall be of the hand or foot-operated type, as specified in Appendix B. Foot control shall be by a three-position pedal rocker. Depression of the rocker backwards shall give 'lift' and forwards 'drop' whilst the central position shall be 'off'. The controller shall remain positively located at 'lift' and 'off' but shall be fitted with a spring return from the 'drop' to the 'off' position.

39.1.1 The magnet control and protective gear shall be in accordance with **26** to **33** where applicable.

39.1.2 Details of the magnet isolating switch and fuses are given in **28**. The current rating of the fuses protecting the magnet circuits shall be 150 percent of the working current.

40. MAGNET EARTHING

40.1 If specified in Appendix B, the magnet frame shall be solidly 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 magnet cable drum.

41. AUXILIARY SUPPLIES

41.1 Rectifiers — On ac-cranes, where dc is not otherwise available, rectifiers shall be provided for supplying the control circuits, brakes and magnets, if required. These rectifier units shall be of adequate capacity to supply continuously with the full dc-loads required and 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 and rectifer transformers which shall be double wound. Rectifiers/thyristors used for magnets shall be protected against switch surges.

41.1.1 If a brake or lifting magnet is supplied by a rectifier, the circuit shall be controlled on the dc-side and a suitable discharge resistor shall be installed.

42. PORTABLE LIGHTING

42.1 If a socket for a hand lamp is provided it shall not be connected to a circuit exceeding 250 V dc or 25 V ac. In the case of an ac-circuit the hand lamps socket shall be fed through a double-wound isolating transformer with some part of the secondary winding earthed.

42.2 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 shall be fused.

42.2.1 If provided hand lamps shall comply with relevant Indian Standard (*see* Appendix C).

43. FIXED LIGHTING

43.1 The nominal voltage of lighting circuits shall not exceed 250 V.

43.2 Lighting in the cab shall be in accordance with **18.6**, and in the electrical equipment with **33**.

43.3 Adequate lighting of the bridge walkways and the cab and bridge approaches shall be provided, if specified in Appendix B.

43.4 Underslung lighting shall be provided beneath the bridge as specified in Appendix B.

44. CRANE WARNING LIGHTS

44.1 The crane shall be equipped with warning lights if specified in Appendix B, in which case the function of the lights shall be as specified in Appendix B.

44.2 Each warning light fitting shall contain two electric bulbs connected in parallel, and shall be accessible. Each fitting shall be provided with an anti-vibration mounting and shall not interfere with the driver's vision. When illuminated, the warning lights shall be readily visible from adjacent cranes.

SECTION 4 INSPECTION AND TESTING

45. INSPECTION AND TESTING

45.1 If required by the purchaser and specified in the contract, the purchaser or his authorized representative shall have access to the manufacturer's works at all reasonable times for the purpose of witnessing the manufacture, inspection and testing of all products concerned, or the complete crane, or both.

45.2 Any work found defective or which is not in accordance with the drawings or of the terms of this code or the contract or both may be rejected by the purchaser.

46. TESTS AT MANUFACTURER'S WORKS

46.1 All electrical and mechanical equipment shall be tested in accordance with the appropriate Indian Standards at either the crane maker's or equipment manufacturer's works and test certificates provided, if required by the customer.

46.2 If required by the purchaser and specified in the contract the crane shall be tested at manufacturer's works under full-load and 25 percent overload on hoisting and cross-traverse motions. Travelling gears may be run light to check shaft and gear alignments.

46.3 Any test required by the purchaser beyond those called for in the appropriate Indian Standards, shall be subject to mutual agreement and shall be carried out at the purchaser's expense.

47. TESTS AT PURCHASER'S PREMISES

47.1 Insulation Tests — After erection but before the crane is connected to the supply, the insulation of the electrical equipment shall be tested by a suitable instrument and any defects revealed shall be rectified.

47.1.1 The voltage required for the insulation resistance test shall be a dc-voltage not less than twice the rated value.

47.1.2 Any reading less than 0·5 MΩ obtained with an insulation resistance tester of the unregulated type shall be disregarded and the wiring under test shall be sub-divided until a reading higher than 0·5 MΩ is obtained. Failure to obtain higher reading shows an unsatisfactory state of the insulation.

NOTE — A reading below 0·5 MΩ obtained with such a tester may indicate that unduly low proportion of the prescribed test voltage is in fact being applied.

47.1.2.1 If any installation has been sub-divided for test purposes, each sub-division shall meet the requirements.

47.1.3 The insulation resistance of each wiring circuit exclusive of connected apparatus shall be not less than 2 MΩ. If necessary, it shall be permissible to disconnect individual items of equipment while conducting this test.

47.2 Tests for Operation — After the supply has been connected and before the complete crane installation is put into commercial service, tests shall be carried out to prove the following:

a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavourable conditions;

b) The correctness of all circuits and interlocks and sequence of operation;

c) The satisfactory operation of all protective devices;

d) The satisfactory operation of each motion of the crane;

e) The compliance of the crane with the specified performance requirements; and

f) Tolerance on specified speeds at full load shall be with ±10 percent.

NOTE — In the case of erection of the crane by a party other than the supplier, the purchaser shall satisfy the supplier before the above tests are carried out that the erection of crane has been done according to the supplier's requirements.

48. DEFLECTION TESTS

48.1 The deflection test shall be carried out with the safe working load at rest and with the crab in a central position. The measurements shall not be taken on the first application of the load. The datum line for measuring the deflection should be obtained by placing the crab on the extreme end of the crane span with smaller hook approach (*see* **13.1.2** of IS : 807-1976*).

49. OVERLOAD TESTS

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

*Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (*first revision*).

49.2 During the overload test each motion in turn shall be manoeuvred in both directions and the crane shall sustain the load under full control. The specified speeds need not be attained but the crane shall show itself capable of dealing with the overload without difficulty.

NOTE — Test load and necessary lifting tackles shall be provided by the purchaser.

APPENDIX A

(*Clauses* 0.3 *and* 1.1)

LIST OF THE STEEL PLANT CRANES AND SPECIAL SERVICES MACHINES COVERED BY THE CODE

A-1. This specification applies to the following types of cranes and special service machines. (The list is not exhaustive):

a) Coke ovens charging.

b) Coke ovens drawing (coke pushers).

c) Blast furnace cast house.

d) Pig machine.

e) Ladle cranes used in the charging and/or tapping of hot metal mixer vessels, Bessemer converters of LD vessels, open hearth and electric furnaces, etc.

f) All cranes and machines (either floor mounted or running on over-head gantries) used to cold charge open hearth or electric furnace, etc, or used to charge and draw all types of reheating furnaces.

g) Bucket handling cranes at various raw and scrap material stock yards, crab cranes and bridges handling, coal, ore, limestone, etc, or by-product or waste materials, such as slag, cinder and mill scale.

h) Magnet cranes used for skull cracking, and for handling and preparing steel scrap.

j) Magnet and cradle cranes for handling semi-finished steel (such as slabs, blooms and billets) and for stocking and shipping finished products (such as structurals, rails, plates and sheets) in the various mills and departments.

k) Ingot and ingot mould handling cranes at stripper yards, ingot stock yards and soaking pit buildings, etc.

m) Mill building cranes for changing stands and rolls in the various mills.

n) Cranes and repair trolleys on fixed high level gantries for the servicing and repair of furnaces or of ladle cranes or stripper cranes, etc.

NOTE — This code is not intended for application to those cranes within the confines of a steel plant which are ancillary to the plant production processes. It is recommended that these cranes should be designed and manufactured in accordance with the appropriate classification in IS : 3177-1977*.

APPENDIX B

[*Clauses* 4.1, 18.1, 25.3, 30.2, 35.3.3, 35.4, 39.1, 39.1.1, 39.2, 39.4, 39.6(c), 44.3, 44.4 *and* 45.1]

INFORMATION TO BE SUPPLIED WITH THE ENQUIRY OR ORDER

B-0. The purchaser shall specify his requirements by filling in certain portions of the following proforma as indicated under each section heading. The other portions refer only to additional requirements and need only be completed where these are specifically required, and should be crossed if not deemed necessary.

Where the purchaser is unable to fill in any particular portion, the requirement should be made the subject of agreement between the purchaser and the manufacturer, and the purchaser should state this in the relevant paragraph.

B-1. GENERAL

B-1.1 Number of cranes:.....

B-1.2 Duty or class of crane:.....

a) Crane structure (*see* 5 of IS : 807-1976†)
b) Main hoist
c) Auxiliary hoist (*see* 5)
d) Cross-traverse
e) Long-travel

*Code of practice for design of overhead travelling cranes and gantry cranes other than steelworks cranes (*first revision*).

†Code of practice for design, manufacture, erection and testing structural portion) of cranes and hoists (*first revision*).

B-1.3 Safe working load in tonnes:

a) Main hoist.....tonnes
b) Auxiliary hoist.....tonnes
c) Second auxiliary hoist.....tonnes
d) Stripping and extracting capacity in case of stripper cranes .....tonnes

NOTE — In case of magnet and grabbing cranes, the specification and physicals condition of the material to be handled shall be given.

B-1.4 Gantry or track rail (*see* Fig. 3):

a) Size and weight .....tonnes
b) Width of head (*B*) .....mm
c) Allowable gantry loadings.....tonnes

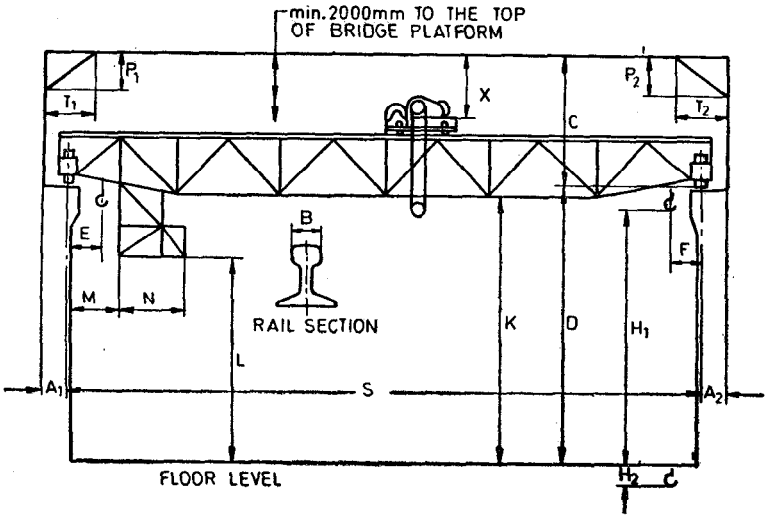

FIG. 3 OVERHEAD TRAVELLING CRANE

B-1.5 Any abnormal atmospheric conditions (to be specified).....

a) Ambient temperature in °C (*Max* and *Min*).
b) Relative humidity (*Max*).

B-1.6 Number of tender documents, including drawings and relevant technical literature required .....

B-1.6.1 Any requirement for:

a) Detailed drawings for approval by purchaser .....
b) As made in drawings.....

B-2. CRANE PERFORMANCE

B-2.1 a) With magnet (where supplied) in plate, the crane shall perform the following duty cycle in .....seconds, rest for.....seconds, then repeat cycle for a period of .....hours, and rest for ..... hours

b) Alternate information.....
.....

c) Duty cycle.....
.....

1) Lift weight of.....tonnes to a height of.....metres
2) Cross-traverse.....metres
3) Long-travel.....metres
4) Longer load to ground and release load, raise hoist.....
..... metres
5) Cross-traverse back..... .....metres
6) Long-travel back.....metres

B-2.2 Operating Speeds (Loaded), not Less than

a) Main hoist.....m/min
b) First auxiliary hoist.....m/min
c) Second auxiliary hoist.....m/min
d) Cross-traverse (main).....m/min
e) Cross-traverse (auxiliary).....m/min
f) Long-travel.....m/min

B-3. STRUCTURAL DETAILS (*See* Fig. 3)

B-3.1 Distance Between Centre Lines of Gantry or Track Rails (S)
.....metres (span)

NOTE — It is recommended that the span of the track shall not vary by more than ±12 mm. When the track span does not satisfy this requirement the maximum and minimum span for which the crane has to be designed shall be specified by the purchaser.

B-3.2 a) Side clearance — Distance from centres of gantry or track rails to nearest side:

1) .....(A_1) metres
2) .....(A_2) metres

b) Distance from top of gantry rail to:

1) Lowest overhead obstruction (C).....metres
2) Floor level (D).....metres

B-3.3 End Clearances:
(P_1).....metres
(P_2).....metres
(T_1).....metres
(T_2).....metres
(R_1).....metres
(R_2).....metres

B-3.4 Vertical Clearance to Underside of Bridge:
(K).....metres

B-3.5 Operator's Cabin:
a) Clearance height to under side of cab (L).....metres
b) Length of cab (N).....metres
c) Distance from back of cab to nearest gantry rail (for fixed cabs) (M).....metres

B-3.6 Lift of Hook Above Floor Level:
a) Main hook (H_1).....metres
b) First auxiliary hook.....metres
c) Second auxiliary hook.....metres

B-3.7 Drop of Hook Below Floor Level:
a) Main hook (H_2).....metres
b) First auxiliary hook.....metres
c) Second auxiliary hook.....metres

B-3.8 Nearest Position of Hook to Centre of Gantry Rail:
a) Main hoist:
1) Cabin end (E).....metres
2) Cabin end (F).....metres
b) First auxiliary hoist:
1) Cabin end (E).....metres
2) Cabin end (F).....metres
c) Second auxiliary hoist:
1) Cabin end (E).....metres
2) Cabin end (F).....metres

B-3.9 Any Other Site Restrictions.....

B-4. OPERATOR'S CABIN DETAILS

B-4.1 a) Type of cabin (fixed or moving).....
b) Location on bridge, if fixed.....
B-4.2 Open or closed type.....

B-4.3 Any Requirement for:

a) Steel plate of thicknesses other than 3·15 mm.....

b) Insulated cab walls.....

c) Insulated floors.....

d) Window opening on hinges.....

e) Dispensing with platform outside cab door.....

f) An extraction fan (door should open inwards where platform is not provided).....

g) A circulating fan.....

h) Air-conditioning for totally enclosed cabs.....

j) Fire extinguishers.....

k) Seating arrangement for crane operator.....

B-5. MECHANICAL DETAILS

B-5.1 General

a) Type of long travel drive.....

b) Make and type of flexible couplings.....

c) Type of any overload slip device (fluid coupling, plate-clutch, or cone clutch).....

B-5.2 Typ e of Hooks:

a) Main hoist.....

b) First auxiliary.....

c) Second auxiliary.....

B-5.3 Any Requirement for:

a) A lifting beam on outdoor cranes.....

b) Built in jacks on end carriages.....

c) Built in jacks on crabs.....

d) Special rail wheel tyres.....

e) Special gearing arrangements or details.....

f) Bearings other than ball or roller type.....

g) Bearings having full ring cartridge housings.....

h) Centralized lubricating system.....

j) Locking device on swivelling hooks.....

k) Closing fingers on the hooks.....

B-6. ELECTRICAL DETAILS

B-6.1 Electric Supply

a) dc-supply

Volts.....No. of wires.....
Supply (rectifiers or not).....

b) ac-supply

Volts.....No. of wires.....
Frequency.....No. of phases.....
Neutral (earthed or not).....

B-6.2 Braking

Any requirements for:

a) electromechanical shunt brake(s) on hoist motion(s).....
b) emergency brake(s) on hoist motion(s) of moving cab cranes (electromechanical shunt, mechanical or hydraulic).....
c) emergency electro-mechanical shunt brake(s) on:
   1) the hoist motions of fixed cab cranes.....
   2) the cross-travel motion(s) of moving cab cranes.....
   3) the long travel motion of fixed cab cranes.....
d) emergency lowering of load by hand operation of brakes.....
e) a mechanical drag brake on crab.....
f) brake magnet coils to be fed from ac.....
g) alternative brake magnet coil ratings.....
h) additional brakes for other motions or purposes.....

B-6.3 Motors

a) Manufacturer of main motors.....
b) Class of insulation of main motors.....
c) dc-mill motor details (if not selected from any standard specification)

Motion	*Motor Frame*	kW	*STR* or IDF†*	*Voltage*	*Class of Insulation*	*Temperature Rise*	*Rev/Min*		
							Series	Compound	Shunt

*STR = short time rating.
†IDF = intermittent duty factor.

d) Any special motor lead or terminal requirements.....

B-6.4 Main Control Gear

B-6.4.1 Type of control panels (open or separate closed units).....

B-6.4.2 Short time rating or duty cycle ratings of resistors:

a) Hoist motions.....

b) Cross-travel motions.....

c) Long-travel motions.....

B-6.4.3 Scheme of protection for main control circuits:

a) Protection of each motion, or.....

b) Tripping out crane supply if overload on any motion .....

B-6.4.4 Any requirement for:

a) a special control system, or a control system other than automatic control of acceleration for any motion (for example, drum or mechanically operated contactor controller) .....

Motion	Control System

b) emergency rheostatic braking on travel motions:

1) cross-travel.....

2) long-travel.....

c) an electrically operated main circuit-breaker.....

d) special clearances of creepages.....

B-6.5 Auxiliary Switching

B-6.5.1 Any requirement for:

a) special position of:

1) main isolating switch.....

2) additional main isolating switch.....

b) HBC fuse protection for main isolators.....

c) auxiliary contacts on the main isolating switch to operate the crane warning lights.....

d) an isolating switch on the main circuit of each motion.....
e) an isolating switch on the control circuit of each motion.....
f) special creeping button to by-pass lower hoist limit switches.....
g) track switches (number, details and whether to operate a warning signal, or trip the main circuit-breaker) .....
h) proximity warning devices (number, location and duty).....

B-6.6 Disposition and Housing of Electrical Equipment

B-6.6.1 Location of electrical equipment compartment for:

a) fixed cab cranes (below or above the bridge platform, or above the cab).....
b) moving cab cranes (above the bridge platform level, or above the cab).....

B-6.7 Long-travel System:

B-6.7.1 Provision of long-travel collectors (purchaser or manufacturer).....

B-6.7.2 Details of mountings on bridge structure for long-travel collectors, if these are to be provided by the purchaser.....

B-6.7.3 Details of long-travel conductors if long-travel collectors are to be provided by the manufacturer.....

B-6.7.4 Type of long-travel collectors if these are to be provided by the manufacturer.....

B-6.8 Cross-travel System:

B-6.8.1 Any requirement for flexible cable type of cross-travel system.....

B-6.8.2 Type of cross-travel conductors (rolled steel section or wires).....

B-6.8.3 Maximum current density for cross-travel conductors (if higher than that recommended in this specification).....

B-6.8.4 Provision of cross-travel collectors (purchaser or manufacturer) .....

B-6.8.5 Details of mountings on the trolley for cross-travel collectors, if these are to be provided by the purchaser.....

B-6.8.6 Type of cross-travel collectors, if these are to be provided by the manufacturer.....

B-6.9 Lifting Magnet and Equipment:

B-6.9.1 If lifting magnets and magnet control and protective gear are to be provided.....

a) Type and size of magnets.....

b) Type of magnet control (direct-on-line or potentiometer)....

c) Type of master controller for direct-on-line control (hand or foot-operated)....

d) Type of potentiometer control (master drum or mechanically operated contactor controller)....

B-6.9.2 Any requirement for:

a) provision for future fitting of a lifting magnet (number of extra cross-travel conductors)....

b) rubber hose protection of magnet lead....

c) special type of magnet coupling....

B-6.10 Crane Illumination and Warning Lights:

Any requirement for:

a) lighting of the bridge walkway and the cab and bridge approaches....

b) underslung lighting (number, type and location of lamps and lamp fittings)....

c) 1) warning lights....

2) if so, give details of their function....

B-6.11 Earthing

Any requirement for:

a) earthing other than through crane gantry....

b) the magnet to be earthed by a connection via the magnet lead, coupling and cable and an extra slip-ring on the magnet cable drum....

B-7. PROTECTION OF CRANE STRUCTURE AND MACHINERY

B-7.1 Any Requirement for Special Painting Schemes....

B-8. ADDITIONAL REQUIREMENTS

B-8.1 Any Additional Requirements....

NOTE — Information regarding items **B-1.1** to **B-1.4**, **B-2.1**, **B-2.2**, **B-3.1** to **B-3.8**, **B-4.1**, **B-4.2**, **B-6.1** to **B-6.3**, **B-6.4.1** to **B-6.4.3**, **B-6.6** (a), **B-6.6** (b) **B-6.7.1** to **B-6.7.4**, **B-6.8.4**, **B-6.8.5** or **B-6.8.6** are essential and should be completed.

APPENDIX C

(*Clauses* 7.1, 13.1, 13.6.5, 15.1, 15.2.1, 17.1, 26.4, 28.2, 32.1, 35.3.3, 38.1, 38.3, 39.3.1 *and* 43.2.1)

LIST OF RELEVANT INDIAN STANDARDS

C-1. MATERIALS

C-1.1 Steels and Castings

IS : 210-1978	Specification for grey iron castings (*third revision*)
IS : 226-1975	Specification for structural steel (standard quality) (*fifth revision*)
IS : 961-1975	Specification for structural steel (high tensile) (*second revision*)
IS : 1030-1982	Specification for carbon steel castings for general engineering purposes (*third revision*)
IS : 1387-1967	General requirements for the supply of metallurgical materials (*first revision*)
IS : 1570-1961	Schedule for wrought steels for general engineering purposes
IS : 2062-1984	Specification for weldable structural steel (*third revision*)

C-1.2 Threaded Fasteners

IS : 1364 (Part 1)-1983	Specification for hexagon head bolts, screws and nuts of product grades A and B: Part 1 Hexagon head bolts (size range M3 to M36) (*second revision*)
IS : 1364 (Part 2)-1983	Specification for hexagon head bolts, screws and nuts of product grades A and B: Part 2 Hexagon screws (size range M3 to M36) (*second revision*)
IS : 1364 (Part 3)-1983	Specification for hexagon head bolts, screws and nuts of product grades A and B: Part 3 Hexagon nuts (size range M 1·6 to M36) (*second revision*)
IS : 1367 (Part 1)-1980	Technical supply conditions for threaded fasteners: Part 1 Introduction and general information (*second revision*)

IS : 1367 (Part 2)-1979	Technical supply conditions for threaded fasteners: Part 2 Product grades and tolerance (*second revision*)
IS : 1367 (Part 3)-1979	Technical supply conditions for threaded fasteners: Part 3 Mechanical properties and test methods for bolts, screws and studs with full leadability (*second revision*)
IS : 1367 (Part 5)-1980	Technical supply conditions for threaded fasteners: Part 5 Mechanical properties and test methods for set screws and similar threaded fasteners not under tensile stresses
IS : 1367 (Part 6)-1980	Technical supply conditions for threaded fasteners: Part 6 Mechanical properties and test methods for nuts with specified proof loads (*second revision*)
IS : 1367 (Part 7)-1980	Technical supply conditions for threaded fasteners: Part 7 Mechanical properties and test methods for nuts without specified proof loads (*second revision*)
IS : 1367 (Part 9)-1979	Technical supply conditions for threaded fasteners: Part 9 Surface discontinuities on bolts, screws and studs (*second revision*)
IS : 1367 (Part 10)-1979	Technical supply conditions for threaded fasteners: Part 10 Surface discontinuities on nuts (*second revision*)
IS : 1367 (Part 12)-1981	Technical supply conditions for threaded fasteners: Part 12 Phosphate coating on threaded fasteners (*second revision*)
IS : 1367 (Part 13)-1983	Technical supply conditions for threaded fasteners: Part 13 Hot-dip galvanized coatings on threaded fasteners (*second revision*)
IS : 1367 (Part 16)-1979	Technical supply conditions for threaded fasteners: Part 16 Designation system and symbols (*first revision*)
IS : 1367 (Part 18)-1979	Technical supply conditions for threaded fasteners: Part 18 Marking and mode of delivery (*second revision*)

C-1.3 Wire Ropes

IS : 1856-1977 Specification for steel wire ropes for haulage purposes (*second revision*)

IS : 2266-1977 Specification for steel wire ropes for general engineering purposes (*second revision*)

IS : 2365-1977 Specification for steel wire suspension ropes for lifts, elevators and hoists (*first revision*)

IS : 2762-1982 Specification for wire rope slings and sling legs (*first revision*)

IS : 3973-1984 Code of practice for selection, installation and maintenance of wire ropes (*first revision*)

IS : 6594-1977 Technical supply conditions for steel wire ropes and strands (*first revision*)

C-2. MECHANICAL AND FABRICATION DETAILS

C-2.1 Keys and Keyways

IS : 2048-1983 Specification of parallel keys and keyways (*second revision*)

IS : 2291-1981 Specification for tangential keys and keyways (*second revision*)

IS : 2292-1974 Specification for taper keys and keyways (*first revision*)

IS : 2293-1974 Specification for gib-head keys and keyways (*first revision*)

IS : 2294-1980 Specification for woodruff keys and keyways (*first revision*)

IS : 6166-1971 Specification for thin taper keys and keyways

IS : 6167-1971 Specification for thin parallel keys and keyways

C-2.2 Welding

IS : 816-1969 Code of practice for use of metal arc welding for general construction in mild steel (*first revision*)

IS : 818-1968 Code of practice for safety and health requirements in electric and gas welding and cutting operations (*first revision*)

IS : 823-1964 Code of procedure for manual metal arc welding of mild steel

IS : 1024-1979 Code of practice for use of welding in bridges and structures subject to dynamic loading (*first revision*)

IS : 1323-1982 Code of practice for oxy-acetylene welding for structural work in mild steel (*second revision*)

C-2.3 Gears

IS : 2467-1963 Notation for toothed gearing

IS : 2535-1978 Basic rack and modules of cylindrical gears for general engineering and heavy engineering (*second revision*)

IS : 3734-1963 Dimensions for worm gearing (*first revision*)

IS : 4460-1967 Method for rating of machine cut spur and helical gears

IS : 5037-1969 Basic rack and modules of straight beval gears for general engineering and heavy engineering

IS : 6535-1979 Data for procurement of straight beval gears (*first revision*)

IS : 7403-1974 Code of practice for selection of standard worm and helical gear boxes

IS : 7504-1974 Methods of inspection of spur and helical gears

IS : 10911-1984 Method of inspection for straight beval gears

C-3. ELECTRICAL DETAILS

C-3.1 Motors

IS : 325-1978 Specification for three-phase induction motors (*fourth revision*)

IS : 900-1965 Code of practice for installation and maintenance of induction motors (*revised*)

IS : 1231-1974 Dimensions of three-phase foot-mounted induction motors (*third revision*)

IS : 2223-1983 Dimensions of flange mounted ac-induction motors (*second revision*)

IS : 4722-1968 Specification for rotating electrical machines

C-3.2 Cables and Conductors

IS : 434 (Part 1)-1964	Specification for rubber insulated cables: Part 1 With copper conductors (*revised*)
IS : 434 (Part 2)-1964	Specification for rubber insulated cables: Part 2 With aluminium conductors (*revised*)
IS : 693-1965	Specification for varnished cambric insulated cables (*revised*)
IS : 694-1977	Specification for PVC insulated cables for working voltages up to and including 1 100 volts (*second revision*)
IS : 1554 (Part 1)-1976	Specification for PVC insulated (heavy duty) electric cables: Part 1 For working voltages up to and including 1 100 V (*second revision*)
IS : 1554 (Part 2)-1981	Specification for PVC insulated (heavy duty) electric cables: Part 2 For working voltages from 3·3 kV up to and including 11 kV (*first revision*)
IS : 8130-1984	Specification for conductors for insulated electric cables and flexible cords (*first revision*)

C-3.3 Switchgear

IS : 2147-1962	Specification for degrees of protection provided by enclosures for low-voltage switchgear and controlgear
IS : 2516 (Parts 1 and 2/ Sec 1)-1977	Specification for circuit breakers: Part 1 Requirements and tests, Section 1 Voltages not exceeding 1 000 V ac or 1 200 V dc (*first revision*)
IS : 2516 (Part 1/Sec 2)-1980	Specification for circuit-breakers: Part 1 General and definitions, Section 2 For voltages above 1 000 V ac (*first revision*)
IS : 2516 (Part 1/Sec 3)-1972	Specification for circuit-breakers: Part 1 Requirements, Section 3 Voltages above 11 kV
IS : 2516 (Part 2/Sec 2)-1980	Specification for circuit-breakers: Part 2 Rating, Section 2 For voltages above 1 000 V ac (*first revision*)

IS : 2516 (Part 3/ Sec 2)-1980	Specification for circuit-breakers: Part 3 Design and construction, Section 2 For voltages above 1 000 V ac (*first revision*)
IS : 2516 (Part 4/ Sec 2)-1980	Specification for circuit-breakers: Part 4 Type tests and routine tests, Section 2 For voltages above 1 000 V ac
IS : 2516 (Part 5/ Sec 2)-1980	Specification for circuit-breakers: Part 5 Information to be given with enquiries, tenders and orders and rules for transport, erection and maintenance, Section 2 For voltages above 1 000 V ac (*first revision*)
IS : 3427-1969	Specification for metal-enclosed switchgear and controlgear for voltages above 1 000 V but not exceeding 11 000 V
IS : 4064 (Part 1)-1978	Specification for air-break switches, air break disconnectors, air-break switch-disconnectors and fuse-combination units for voltages not exceeding 1 000 V ac or 1 200 V dc: Part 1 General requirements (*first revision*)
IS : 4064 (Part 2)-1978	Specification for air-break switches, air-break disconnectors, air-break switch disconnectors and fuse-combination units for voltages not exceeding 1 000 V ac or 1 200 V dc: Part 2 Specific requirements for the direct switching of individual motors (*first revision*)
IS : 8544 (Part 1)-1977	Specification for motor starters for voltages not exceeding 1 000 V: Part 1 Direct-on-line ac-starters
IS : 8544 (Part 2)-1977	Specification for motor starters for voltages not exceeding 1 000 V: Part 2 Star delta starters
IS : 8544 (Part 3/ Sec 2)-1979	Specification for motor starters for voltages not exceeding 1 000 V: Part 3 Rheostatic rotor starters, Section 2 Additional requirements for ac-rheostatic rotor controllers

IS : 8544 (Part 4)-1979	Specification for motor starters for voltages not exceeding 1 000 V: Part 4 Reduced voltage ac starters, two-step auto transformer starters
IS : 10118 (Part 1)-1982	Code of practice for selection, installation and maintenance of switchgear and control gear: Part 1 General
IS : 10118 (Part 2)-1982	Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 2 Selection
IS : 10118 (Part 3)-1982	Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 3 Installation
IS : 10118 (Part 4)-1982	Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 4 Maintenance

C-3.4 Earthing

IS : 3043-1966	Code of practice for earthing

APPENDIX D

(*Clauses* 23.1.1 *and* 26.1.5)

NOTES ON DESIGN AND SELECTION OF MOTORS

D-1. MOTORS FOR HOIST MOTIONS

D-1.1 Direct Current Motors — The motors shall be so selected that their one hour power rating is not less than that computed from the following formula:

$$\text{Power} = \frac{KMV}{4{\cdot}56\,E}$$

where

M = weight of the rated load on the hook plus weight of the hook block and the wire ropes in tonnes,

V = specified hoisting speed in m/min, and

E = combined efficiency of gears and sheaves,

$= (0{\cdot}93)^n \times (0{\cdot}98)^m$ for sleeve bearings

$= (0{\cdot}95)^n \times (0{\cdot}99)^m$ for antifriction bearings

where

n = numbers of pairs of gears,

m = total number of rotating sheaves between drum and equaliser passed over by each part of the moving rope attached to the drum, and

K = service factor depending on the electrical service class of crane.

D-1.1.1 Recommended values of K for series motors operated at 230 volts is given in Table 6.

TABLE 6 VALUES OF FACTOR 'K' FOR HOIST MOTOR (SERIES MOTOR)

Duty Cycle	Electrical Service Class	Service Factor K
Not more than 20 percent time ON and not more than 15 cycles per hour	1	0·75
21-30 percent time ON or 16-25 cycles per hour	2	0·75
31-40 percent time ON or 26-35 cycles per hour	3	0·82
41-50 percent time ON or 36-45 cycle per hour	4	0·96

D-1.1.1.1 For voltages other than 230 volts, use the one-hour ratings at the selected voltage, as established by the motor manufacturer.

D-1.1.1.2 For duty cycle of more than 50 percent time 'ON' or 45 cycles per hour, the requirements must be submitted to the motor manufacturer for selection of adequate ratings.

D-1.2 Alternate Current Motors — The motors shall be so selected that its power rating at 40 percent duty factor is not less than that computed from the following formula:

$$\text{Power} = \frac{KMV}{4{\cdot}56\,E}$$

where

M = weight of the rated load on the hook plus weight of the hook block and the wire ropes in tonnes,

V = specified hoisting speed in m/min,

K = service factor depending on electrical service class of crane, and

E = combined efficiency of gears and sheaves

$= (0{\cdot}93)^n \times (0{\cdot}98)^m$ for sleeve bearings

$= (0{\cdot}95)^n \times (0{\cdot}99)^m$ for antifriction bearings

where

n = number of pairs of gears, and

m = total number of rotating sheaves between drum and equaliser passed over by each pari of the moving rope attached to the drum.

D-1.2.1 Recommended values of K for ac-induction motors is given in Table 7.

TABLE 7 VALUES OF FACTOR 'K' FOR HOIST MOTOR (INDUCTION MOTORS)

Duty Cycle	Electrical Service Class	Service Factor K
Not more than 20 percent time ON and not more than 15 cycles per hour	1	1
21-30 percent time ON or 16-25 cycles per hour	2	1
31-40 percent time ON or 26-35 cycles per hour	3	1·1
41-50 percent time ON or 36-45 cycles per hour	4	1·2

D-1.2.1.1 For an ac hoist, the specified full load hoist speed must be obtained at not more than rated torque. Therefore, the calculated full load hoist power must be multiplied by:

$$\frac{(100 - \text{percentage rated slip})}{(100 - \text{percent total ohms at full speed})}$$

D-2. DIRECT CURRENT OR ALTERNATE CURRENT MOTORS FOR BRIDGE TRAVEL OR TROLLEY TRAVERSE

D-2.1 It is assumed that the drive mechanism from the motor to the track wheels will use totally enclosed gearing mounted on antifriction bearings and that the efficiency of the drive will be in the range 0·85 to 0·90 with an average value of 0·875, which will generally be adopted in making calculations for motor power and torques.

D-2.2 In general the track wheel bearings will be antifriction type, in which case rolling friction at these bearings plus the friction between the track wheels and the rails may be assumed at 7·0 kgf/t of mass moved which with a drive efficiency of 0·875 gives an overall friction factor of 8·0 kgf/t for calculation of motor power or torque. Note that the mass moved is the mass of the load plus the mass of the crane or the trolley.

D-2.2.1 Some purchasers, however, may specify that the track wheels are to be mounted on plain bearings. In this case the friction at these bearings plus that between the track wheels and the rails may be assumed to result in an overall friction factor of 13·0 kgf/t of mass moved.

D-3. SELECTION OF FRAME SIZE FOR DIRECT CURRENT MOTORS

D-3.1 The selected motor shall have the one hour power rating which is not less than that computed from the following formula:

$$\text{Selected power} = KMVS$$

where

K = a factor which includes for power to overcome friction, to give linear acceleration to the mass moved, and the angular acceleration to the motor armature and the rotating parts;

M = mass moved in tonnes;

V = specified free running speed in m/min; and

S = a service factor aimed at providing adequate motor heat dissipation capacity to cover for the severity of the expected duty cycle.

D-3.1.1 Recommended values for K and S are given in Tables 8 and 9.

D-3.1.1.1 For other values of acceleration between two figures, intermediate values of K may be taken.

D-3.1.1.2 At crane or trolley free running speed, the acceleration becomes zero and hence the power to be furnished by the motor is:

Case I Track wheels on antifriction bearings,

$$\text{Power required} = \frac{8\ MV}{4\ 562} = 0{\cdot}001\ 75\ MV$$

Case II Track wheels on plain bearings,

$$\text{Power required} = \frac{13\ MV}{4\ 562} = 0{\cdot}002\ 85\ MV$$

TABLE 8 VALUES OF SERVICE FACTOR *K*

(*Clause* D-3.1.1)

Acceleration Whilst on the Resistor cm/s^2	Track Wheels on Antifriction Bearing	Track Wheels on Plain Bearings
15	0·002 5	0·003 3
30	0·003 5	0·004 4
45	0·004 3	0·005 4
60	0·005 1	0·006 3
75	0·005 8	0·007 1

TABLE 9 VALUES OF SERVICE FACTOR *S*

(*Clause* D-3.1.1)

Maximum Percent Time During One Operation Hour	Maximum Round Trips per Hour	Bridge Service Factor		Trolley Service Factor
		Without Plugging	With Plugging	
20	15	1·0	1·1	1·2
30	25	1·1	1·2	1·3
40	35	1·2	1·3	1·4
50	45	1·3	1·4	1·5
More than 50	45	1·4	1·5	—

D-3.1.1.3 If the acceleration values are not specified by the user, this may be chosen corresponding to the speeds to be reached according to the three following working conditions:

a) Appliances of low and moderate speed with a great length of travel,

b) Appliances of moderate and high speed for normal applications, and

c) High speed appliances with high acceleration.

Table 10 gives the values of acceleration for the above three conditions.

TABLE 10 ACCELERATION VALUES

(*Clause* D-3.1.1.3)

Speed to be Reached m/min	Condition		
	Acceleration in cm/s² for Low and Moderate Speed with Long Travel	Acceleration in cm/s² for Moderate and High Speed (Normal Application)	Acceleration in cm/s² for High Speed With High Acceleration
240		50	67
190		44	58
150		39	52
120	22	35	47
100	19	32	43
60	15	25	33
40	12	19	
25	10	16	
15	8		
10	7		

D-3.1.1.4 Since the wheels must transmit all acceleration forces to the crane, to prevent wheel skidding due consideration should be given on percent driven wheels after acceleration rate has been fixed. The wheel skidding should be checked at no-load conditions considering 20 percent adhesion between wheel and rail.

D-3.2 It is essential that the gear reduction ratio actually used be reasonably close to the ideal reduction ratio:

$$\frac{\text{Motor speed when developing calculated free running power}}{\text{Track wheel speed to give specified running speed}}$$

D-3.3 For limiting the acceleration to the specified value and also to take full advantage of the service factor actually used, it is essential that whilst the motor is on the resistor, the electrical control shall limit the average current to a value corresponding to 1·33 times the torque which the selected motor would furnish when developing power of *KMV*, that is *KMVS* with *S* taken as unity.

D-4. SELECTION OF ALTERNATE CURRENT MOTORS

D-4.1 Alternate current motors for bridge or trolley traverse shall be so selected that their power rating at 40 percent duty factor is not less than that computed from the following formula:

$$\text{Selected power} = \frac{MVS}{4\,562\,I}\left(F + \frac{1\,100\,a}{981\,E}\right)$$

where

M = mass moved in tonnes;

V = specified free running speed in m/min;

T = a factor introduced by the permissible motor torque, during acceleration exceeding the motor-rated torque. As a general guidance, value of T may be taken as 1·7 for motors having pull out torque of 275 percent full load torque. Lower values of T should be taken for corresponding lower values of pull out torque;

F = overall friction factor as adopted for dc-cranes and having a value of 8·0 or 13·0 kgf/t for track wheels on antifriction or plain bearings, respectively;

a = average linear acceleration of crane or trolley in cm/s^2 up to 90 percent of the free running speed and will be as given in **D-3.1.1.3** for dc-motors;

E = mechanical efficiency of gearing which may be taken as 0·95 per reduction; and

S = service factor as adopted for selection of dc-motors.

D-4.2 At crane or trolley free-running speed the acceleration becomes zero and hence the power to be furnished by the motor will be as given in **D-3.1** for dc-motor.

D-4.2.1 The gear reduction ratio actually used should be reasonably close to the ideal reduction ratio:

$$= \frac{\text{Motor speed at free running}}{\text{Track wheel speed to give specified running speed}}$$

D-4.2.2 So as to limit the acceleration to the specified value and also to take full advantage of the service factor, the electrical control shall be designed to suit the values of S and T actually adopted.

APPENDIX E

(*Clause* 0.4)

TYPICAL CRANE SERVICE DATA FOR STEEL PLANT CRANES INCLUDING SPECIAL SERVICE MACHINES

E-1. TYPICAL CRANE SERVICE DATA

E-1.1 Typical crane service data for various steel plant cranes including special service machines used in steel plants is given in Table 11.

TABLE 11 TYPICAL CRANE SERVICE DATA FOR STEEL PLANT CRANES INCLUDING SPECIAL SERVICE MACHINES

(*Clause* 0.4)

Sl No.	Crane Type/ Application	Average Number of Hours Operation in One Year	Normal Ambient Temperature During Operation °C	High Ambient Temperature During Operation °C	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class—Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class—Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Lifts Per Hour†	Service Class—Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Lifts Per Hour†	Service Class—Electrical
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
1.	*Coke plant and blast furnace cranes*:																			
	Drawing machine (coke pusher)	7 200	27	56	3 240	45	17	4	2 068	29	9	2	1 296	18	7	1	1 440	20	6	1
	Bucket handling	3 240	27	43	1 458	45	19	4	1 458	45	25	4	2 009	62	25	—	2 106	65	27	—
	Stock yard	6 840	27		3 078	47	14	4	3 762	55	48	—	2 941	43	38	4	2 736	40	100	—
	Slag handling	5 400	27	38	1 670	31	21	3	1 836	34	30	3	2 052	38	21	3	3 240	60	35	—
	Scrap yard	7 200	27		3 240	45	30	4	1 440	20	27	2	4 104	57	80	—				
	Cast house	1 080	27		648	60	32	—	400	37	32	3	616	57	75	—	432	40	20	3
	Pig machine						15	1		90	15	—		90	4	—		5	2	1
	Ladle house	1 800	27		360	20	22	1	630	35	25	—	576	32	15	3	846	47	17	4
	Skull cracker	720	27		36	5	—	1	576	80	30	—	648	90	30	—	14	2	1	1
	Sand house (bucket)	360	27		324	90	21	—	342	95	21	—	54	15	21	1	324	90	20	—
	Setting basin	720	27		360	50	30	4	108	15	60	3	100	25	60	3	216	30	60	3
	Car repair shop	1 440	27		216	15	20	1	288	20	35	2	432	30	40	2	288	20	20	1
	Ore bridge	7 560	27		756	10	10	1	3 780	50	35	4	454	6	35	2	3 024	40	35	3
	Coke ovens (coal bridge)	5 760	27		1 440	25	15	2	2 880	50	78	4	634	11	78	4	2 419	42	78	4
2.	*Open Hearth, Electric Furnace, BOP Cranes*:																			
	Charging machines	6 840	33	44	2 120	31	98	—	3 146	46	89	4	1 847	27	80	4	1 368	20	88	4
	Hot metal crane (charging)	6 480	48	54	2 850	44	27	4	1 426	22	32	2	1 750	27	13	2	2 592	40	31	3
	Ladle	6 480	38	42	2 916	45	33	4	3 110	48	23	4	1 690	26	9	2	1 361	21	18	2
	Metal mixer crane	3 600	33	49	648	18	12	1	1 008	28	18	2	1 981	55	20	—	1 080	30	33	2

NOTE — Wherever a dash mark appears in the service class column, the listed data indicates that the particular motion is required to operate more than 50 percent time on or more than 45 cycles per hour; therefore a value of service factor cannot be assigned and the requirements must be submitted to the supplier for the selection of adequate ratings.

*A cycle for a bridge or trolley consists of two 'moves' — one loaded and one unloaded.

†For hoist drives, one cycle consists of two 'lifts', one loaded and one unloaded, plus two lowering operations. Unless otherwise specified, it will be assumed that full load will be raised and lowered, and that 'no-load' will be raised and lowered through the same distance, using the maximum speeds provided by the selected type of drive, with reasonable rates of acceleration and deceleration.

(*Continued*)

TABLE 11 TYPICAL CRANE SERVICE DATA FOR STEEL PLANT CRANES INCLUDING SPECIAL SERVICE MACHINES — *Contd*

Sl No.	Crane Type/ Application	Average Number of Hours Operation in One Year	Normal Ambient Temperature During Operation °C	High Ambient Temperature During Operation °C	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class— Electrical	Average Number of Hours Operation in One Year	Percent Time on in one - Operational Hour	Number of Moves Per Hour*	Service Class— Electrical	Average Number of Hours Operation in One Year	Percent Time on in one Operational Hour	Number of Lifts Per Hour†	Service Class— Electrical	Average Number of Hours Operation in One Year	Percent Time on in one Operational Hour	Number of Lifts Per Hour†	Service Class— Electrical
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	Electric furnace charging cranes	2 880	33	44	864	30	55	2	1 764	30	60	3	1 728	60	100	—				
	Stock yard	6 480	21	27	1 940	30	76	4	2 851	44	89	4	3 110	48	93	4				
	Scrap preparation					10	64	3		45	64	4		46	32	3				
	Scrap baler crane	7 560			2 040	27	40	2	2 268	30	40	2	3 780	56	80	4				
	Scrap shear crane	7 560			4 990	66	40	—	1 275	17	40	2	4 838	64	80	—				
	Hot top	5 400		54	1 350	25	55	3	810	15	57	3	1 890	35	30	3	2 430	45	90	4
	Bucket	5 040			2 420	48	52	4	2 218	44	49	4	2 066	41	43	4	1 915	38	20	3
	Slag handling	6 480			1 820	28	25	1	1 944	30	8	2	2 268	15	10	3				
	Cinder yard	5 040	21	38	2 120	42	55	4	2 621	52	80	—	3 276	65	82	—	4 032	80	25	—
	Skull cracker	6 480	21	27	1 620	25	70	3	2 592	40	71	3	3 110	48	23	4	3 564	55	37	—
	General service	3 960		38	1 310	33	22	3	911	23	26	2	555	14	23	1	1 584	40	56	3
3.	*Ingot Handling Cranes*																			
	In ot handgling	6 840			1 500	22	30	2	1 163	17	33	2	3 762	55	17	—	342	5	28	1
	Soaking pit	3 960	50	63	1 660	42	42	4	1 703	43	42	4	2 020	51	60	4	838	21	50	2
	Stripper	4 680	21	45	1 070	23	38	2	1 638	35	38	3	2 059	44	64	4	1 123	24	31	2
	Mould yard	6 120	22	38	2 570	42	44	4	1 714	28	63	3	2 815	46	55	4	612	10	20	1
4.	*Rolling Mill Cranes*																			
	Slab yard	6 480	16	38	3 629	56	26	—	1 944	30	34	2	2 786	43	30	4	778	12	16	1
	Slab furnace charging	6 480		41	1 400	30	40	2	1 640	35	45	3	2 800	60	61	—	468	10	10	1
	Plate and strip handling	6 480	43	44	3 694	57	27	—	1 426	22	26	2	2 203	34	41	3				
	Billet mill	4 320		42	1 690	39	23	3	1 166	27	23	2	2 030	47	31	4				

NOTE — Wherever a dash mark appears in the service class column, the listed data indicates that the particular motion is required to operate more than 50 percent time on or more than 45 cycles per hour; therefore a value of service factor cannot be assigned and the requirements must be submitted to the supplier for the selection of adequate ratings.

*A cycle for a bridge or trolley consists of two 'moves' — one loaded and one unloaded.

†For hoist drives, one cycle consists of two 'lifts', one loaded and one unloaded, plus two lowering operations. Unless otherwise specified, it will be assumed that full load will be raised and lowered, and that 'no-load' will be raised and lowered through the same distance, using the maximum speeds provided by the selected type of drive, with reasonable rates of acceleration and deceleration.

(*Continued*)

TABLE 11 TYPICAL CRANE SERVICE DATA FOR STEEL PLANT CRANES INCLUDING SPECIAL SERVICE MACHINES — *Contd*

Sl No.	Crane Type/ Application	Average Number of Hours Operation in One Year	Normal Ambient Temperature During Operation °C	High Ambient Temperature During Operation °C	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class—Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class—Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Lifts Per Hour†	Service Class—Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Lifts Per Hour†	Service Class—Electrical
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	Bilet shipping	7 200	38	38	935	13	10	1	864	12	10	1	1 800	25	35	2				
	Rail mill	3 600			1 440	40	10	3	720	20	20	1	1 800	50	30	4				
	Rail loading dock	3 240	38	38	2 430	75	20	—	1 620	50	20	4	1 620	50	20	4				
	Rail shipping	7 920			3 240	41	30	4	4 356	55	30	—	3 722	47	80	4				
	Hot mill	5 400		46	1 400	26	18	2	1 296	24	22	2	1 188	22	13	2	1 782	33	15	3
	Cold strip mill	6 840	24	38	2 530	37	20	3	1 984	29	27	2	1 505	22	26	2	2 120	31	24	3
	Coil storaged	7 920	24	49	5 227	66	73	—	3 247	41	72	4	3 485	44	66	4				
	Roll shop	4 320	24	33	1 730	40	28	3	1 166	27	24	2	1 037	24	19	2	1 080	25	26	2
	Mill service	5 040	33	43	1 810	36	30	3	1 260	25	30	2	1 663	33	19	3	1 865	37	40	3
	Machine shop	5 040			1 810	36	31	3	1 410	28	41	2	1 560	31	33	3	2 020	40	30	3
	Cooling building	5 760		55	1 840	32	26	3	2 189	38	27	3	2 822	49	35	4				
	Inspection and conditioning	3 600			1 800	50	50	4	1 080	30	45	2	2 520	70	75	—	180	5	10	1
	Pit cover	5 400		38	2 700	50	25	4					1 350	25	20	2	1 350	25	25	2
5.	*Finishing Mill Cranes*																			
	Slab storage	6 480	27	38	1 944	30	40	2	1 944	30	40	2	1 944	30	20	2	324	5	2	1
	Billet yard	3 960			1 660	42	32	4	475	12	32	2	1 069	27	45	2				
	Furance room	4 320			2 592	60	30	—	6 648	15	30	1	1 080	25	30	2				
	Mill service	5 040	27	41	1 870	37	19	3	1 411	28	23	2	1 562	31	17	3	1 109	22	25	2
	Shipping	5 760	21	38	2 995	52	35	—	1 382	24	36	2	2 304	40	52	3				
	Warehouse	5 040	24	38	2 320	46	31	4	1 260	25	32	2	2 419	48	35	4				
	Sorting room	7 200			3 600	50	60	4	1 800	25	60	3	2 160	30	60	3				
	Scale pit	360			126	35	25	3	72	20	25	1	324	90	25	—	324	90	25	—
	Hot bed	1 440			216	15	5	1	144	10	17	1	288	20	15	1				
	Pickling	6 840	27	43	2 800	41	30	4	1 710	25	39	2	2 462	36	47	3				
	Quenching			38		5	2	1		5	2	1		5	2	1				
	Tin mill	6 840	24	38	2 530	37	36	3	1 710	25	41	2	2 394	35	42	3	684	10	20	1

NOTE — Wherever a dash mark appears in the service class column, the listed data indicates that the particular motion is required to operate more than 50 percent time on or more than 45 cycles per hour; therefore a value of service factor cannot be assigned and the requirements must be submitted to the supplier for the selection of adequate ratings.

*A cycle for a bridge or trolley consists of two 'moves' — one loaded and one unloaded.

†For hoist drives, one cycle consists of two 'lifts', one loaded and one unloaded, plus two lowering operations. Unless otherwise specified, it will be assumed that full load will be raised and lowered, and that 'no-load' will be raised and lowered through the same distance, using the maximum speeds provided by the selected type of drive, with reasonable rates of acceleration and deceleration.

(*Continued*)

TABLE 11 TYPICAL CRANE SERVICE DATA FOR STEEL PLANT CRANES INCLUDING SPECIAL SERVICE MACHINES — *Contd*

Sl No.	Crane Type/ Application	Average Number of Hours Operation in One Year	Normal Ambient temperature During Operation °C	High Ambient Temperature During Operation °C	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class— Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Moves Per Hour*	Service Class— Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Lifts Per Hour†	Service Class— Electrical	Average Number of Hours Operation in One Year	Percent Time on in One Operational Hour	Number of Lifts Per Hour†	Service Class— Electrical
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	Annealing	7 200	19	46	2 890	40	22	3	2 232	31	24	3	2 016	28	16	2	2 808	39	25	3
	Battery shop	5 400			540	10	22	1	432	8	22	1	540	10	11	1				
6.	*Rod and Wire Mill Cranes*																			
	Billet yard	7 800	19	31	4 300	55	27	—	2 340	30	27	2	2 730	35	17	3				
	Rod mill	4 300	27	46	3 000	70	25	—	1 300	30	25	2	1 700	40	20	3				
	Rod dock	8 000	16	43	6 400	80	70	—	4 800	60	70	—	3 200	40	50	3				
	Cleaning house	8 000	33	38	4 800	60	100	—	1 600	20	60	3	3 200	40	90	4				
	Pot annealing	6 900	31	43	3 800	55	85	—	2 400	35	65	3	1 700	25	30	2	5 500	80	100	—
	Rod storage	7 300	34	36	4 400	60	34	—	2 200	30	34	2	7 700	10	34	2				
	Patenting department	2 900	33	34	1 900	65	32	—	450	15	32	2	580	20	32	2				
	Bar banding and storage	8 000	16	43	6 400	80	100	—	2 400	30	50	2	3 200	40	40	3				
7.	*Tube Mill Cranes*																			
	Hot mill	8 000	33	60	4 800	60	60	—	1 600	20	60	3	2 640	33	30	3				
	Finishing mill	8 400	27	46	5 050	60	70	—	1 700	20	70	3	2 800	33	35	3				
	Galvanizing	8 400	24	46	5 050	60	70	—	1 700	20	70	3	2 800	33	35	3				
8.	*Miscellaneous Cranes*																			
	Forging manipulators	5 400	27	46	2 480	46	33	4	2 430	45	30	4	1 134	21	18	2	108	2	1	1
	Hydraulic forging cranes	8 640	27	43	3 630	42	17	4	3 197	37	40	3	3 024	35	22	3				
	Warehouse	3 960			1 700	43	16	4	713	18	17	1	990	25	16	2				
	Gantry	5 040	21	33	2 020	40	34	3	2 268	45	81	4	2 520	50	88	4				
	Repair	1 800	27	39	504	28	15	2	360	20	14	1	378	21	12	2	396	22	15	2
	Machine shop	5 040	27	33	2 068	41	21	4	1 310	26	221	2	1 008	20	12	1	1 512	30	18	2
	Service	1 800			610	34	11	3	288	16	12	1	450	25	14	2				
	Power house	1 080	33	46	270	27	8	2	270	27	13	2	260	24	7	2	230	21	13	2
	Motor room	1 080		43	240	22	4	2	162	15	6	1	194	18	4	1	162	15	4	1

NOTE — Wherever a dash mark appears in the service class column, the listed data indicatest hat the particular motion is required to operate more than 50 percent time on or more than 45 cycles per hour; therefore a value of service factor cannot be assigned and the requirements must be submitted to the supplier for the selection of adequate ratings.

*A cycle for a bridge or trolley consists of two 'moves' — one loaded and one unloaded.

†For hoist drives, one cycle consists of two 'lifts', one loaded and one unloaded, plus two lowering operations. Unless otherwise specified, it will be assumed that full load will be raised and lowered, and that 'no-load' will be raised and lowered through the same distance, using the maximum speeds provided by the selected type of drive, with reasonable rates of acceleration and deceleration.

(*Continued from page* 2)

Panel for Reviewing Indian Standards on EOT Cranes, SMDC 26/P-10

Convener	*Representing*
SHRI R. N. BHOWAL	Jessop and Co Ltd, Calcutta
Members	
SHRI S. NAG (*Alternate* I to Shri R. N. Bhowal)	
SHRI S. K. SADHU (*Alternate* II to Shri R. N. Bhowal)	
SHRI S. K. BASU	Steel Authority of India Ltd (Bokaro Steel Plant), Bokaro
ASSISTANT SUPERINTENDENT CRANES (*Alternate*)	
SHRI D. CHATTERJEE	WMI Cranes Ltd, Bombay
SHRI A. D. PATANKAR (*Alternate*)	
SHRI G. C. CHATTERJEE	Braithwaite and Co Ltd, Calcutta
SHRI B. P. RAKSHIT (*Alternate*)	
SHRI H. C. GUPTA	Bombay Cranes, Bombay
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SHRI K. B. KULKARNI	Bhartia Cutler Hammer Ltd, Faridabad
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SHRI R. N. SINHA	Heavy Engineering Corporation Ltd, Ranchi
SHRI J. C. MUKHERJEE (*Alternate*)	
SHRI G. S. SOLANKE	Bharat Heavy Electricals Ltd
SHRI G. K. DAMAL (*Alternate*)	
SHRI SURINDER PAUL	Tak Machinery Ltd, Bombay

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.S
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s(s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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